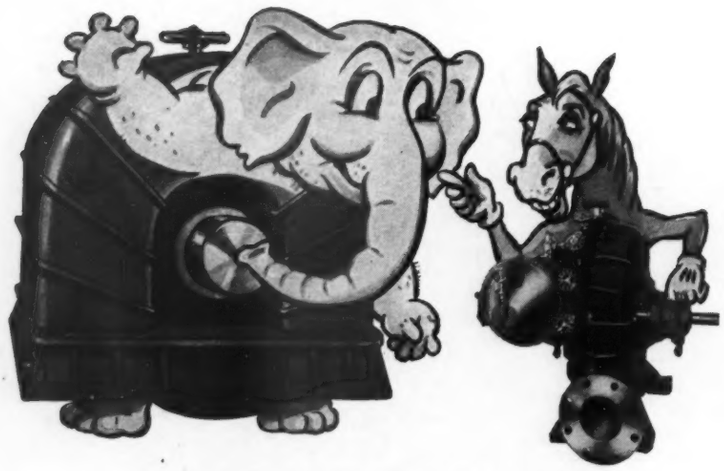
MAR 13 1942

# Compressed Air Magazine

VOLUME 47 • NUMBER 3 MARCH 1942 LONDON • NEW YORK • PARIS

COATING FLUORESCENT LAMP TUBES



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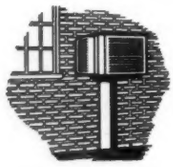

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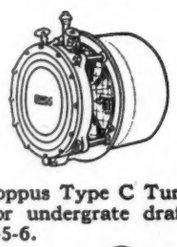

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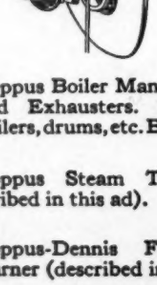

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### ON THE COVER

OUR cover picture shows one of the ways in which compressed air aids in making fluorescent lamps in the new factory of the Westinghouse Electric & Manufacturing Company at Fairmont, W.Va. The fluorescent material, which converts the mercury arc into visible light rays, is applied to the tubes in liquid form. The attendant is holding a tube in which the coating is elevated by air under pressure. At the left are tubes placed on a rack to permit drainage of excess liquid.

•

### IN THIS ISSUE

ONE of the aftermaths of the first World War was a startling increase in defective vision among industrial workers who spent long hours in inadequately lighted factories. In the present emergency every effort is being made to prevent a recurrence of that condition, and the new fluorescent lamp is proving a big help towards that end. The problem is only half solved, however, if the workers return to poorly lighted homes at night and if their children spend their days in badly illuminated classrooms. One out of every five draftees examined for military service last year was rejected for defective eyesight. Authorities are agreed that the nation must set up new standards of minimum illumination. In this broad movement, fluorescent lighting, which is the subject of our first article, is probably destined to play an important part.

•

IN CONSTRUCTING a zoo, consideration should be given to providing the inmates with comfortable quarters that not only simulate their native haunts as closely as possible but also display them to advantage. These requisites are being met admirably at The Bronx Zoo in New York by new facilities, which are described in an article starting on page 6680.

•

EVER since John Harrison hit upon a way of making chilled-steel shot for abrasive purposes some 65 years ago, there has been one Harrison or more in the business in this country or in England. Nathan C. Harrison, the youngest of seven sons, devoted many years to literally scouring the earth for emery, corundum, and other natural abrasives. After making and losing several sizable fortunes in these peregrinations, he settled down four years ago to manufacture shot by his father's ingenious method. How he has built up the business since then to a place among the leaders in that field is told in this issue.

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THE article on *All Kinds of Ways to Dig* takes us to a New Mexico cave where evidences have been unearthed indicating that a race of men inhabited America long before the coming of the Indian.


# Compressed Air Magazine



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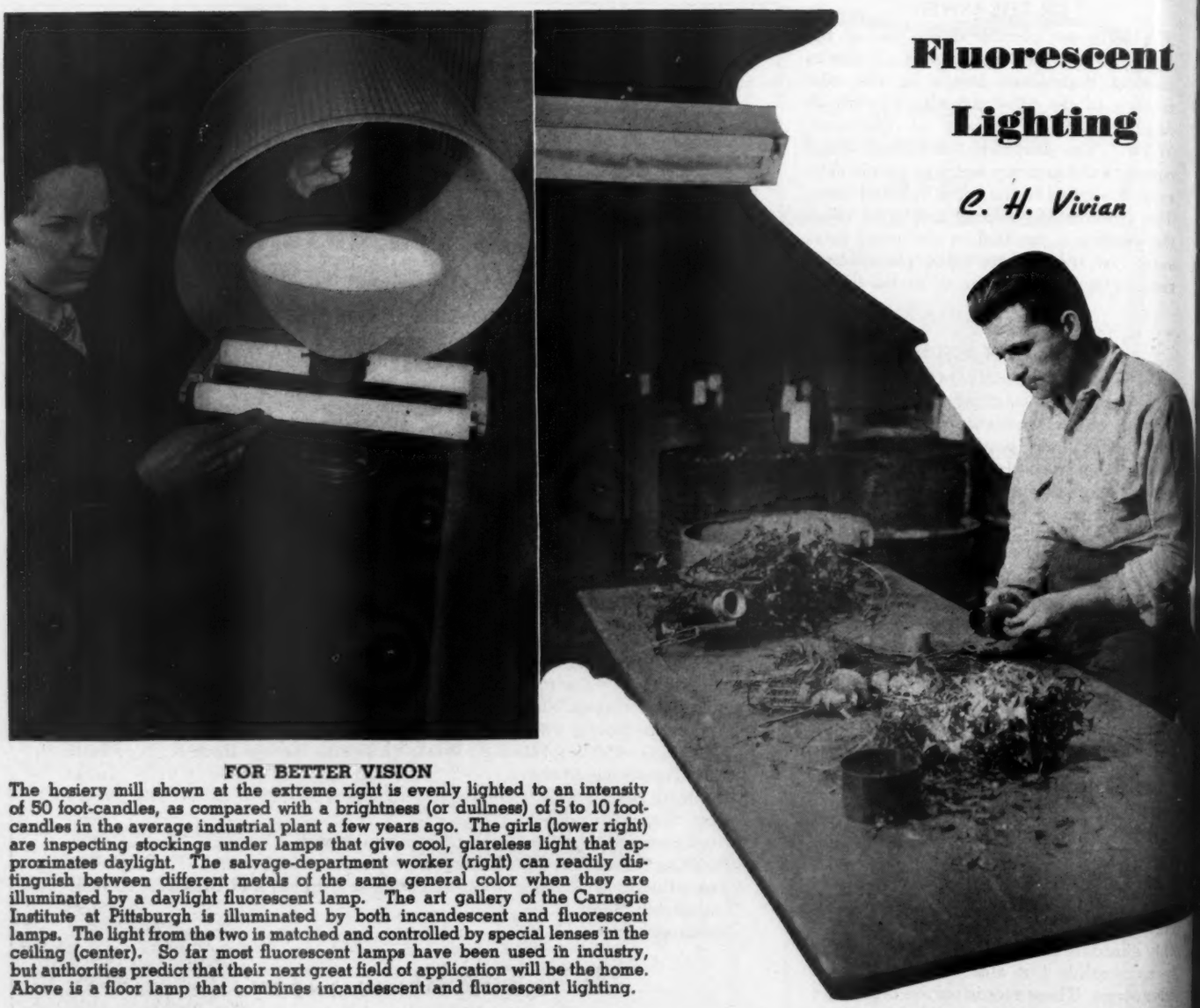
# Fluorescent Lighting

C. H. Vivian



**FOR BETTER VISION**

**The hosiery mill shown at the extreme right is evenly lighted to an intensity of 50 foot-candles, as compared with a brightness (or dullness) of 5 to 10 foot-candles in the average industrial plant a few years ago. The girls (lower right) are inspecting stockings under lamps that give cool, glareless light that approximates daylight. The salvage-department worker (right) can readily distinguish between different metals of the same general color when they are illuminated by a daylight fluorescent lamp. The art gallery of the Carnegie Institute at Pittsburgh is illuminated by both incandescent and fluorescent lamps. The light from the two is matched and controlled by special lenses in the ceiling (center). So far most fluorescent lamps have been used in industry, but authorities predict that their next great field of application will be the home. Above is a floor lamp that combines incandescent and fluorescent lighting.**

ARTIFICIAL lighting has been improved more during the past three or four years than in any equal period since Edison invented the carbon-filament incandescent electric lamp some 60 years ago. Numerous new illuminants have been introduced, and each of them is suited for a specific lighting service. Of these, the fluorescent lamp is the most conspicuous, and its rise in popularity has been spectacular in its swiftness. The first of these tubular light sources was made in 1938, and before the year ended 250,000 of them were sold. In 1939, the output rose to around 2,000,000, and in 1940 it soared to 7,000,000. Last year there was a further increase of more than 300 per cent to a total of 22,000,000. Demand has been running far ahead of production capacity for many months, and the 1942 sales will be limited solely by the number of units that can be turned out. Leading manufacturers estimate that this will be about 40,000,000 lamps.

So far the greatest application of fluorescent lamps has been in the field of industrial and commercial lighting, and that tendency will probably continue for some years to come. The new illuminants are satisfactory light sources for certain residential services, but are not at present recommended for general home use. Authorities are agreed that the familiar tungsten-filament incandescent lamp will supply most of that illumination for a long time. It has been improved steadily, and now gives 2½ times as much light for the same cost as it did in 1926. It is made in some 6,000 sizes and types, and more are being added each year. To increase its efficiency further, manufacturers spend annually for research an average of $3,000,000.

The fluorescent lamp gives about 2½ times as much light as an incandescent lamp with the same wattage. In other words, a 40-watt fluorescent will have a lighting intensity equal to that of a 100-watt incandescent. Moreover, it generates only half as much radiant heat (the kind we feel) for each watt of current consumed. Only half the heat of a fluorescent lamp is radiated, the remainder being lost, usually upward, by conduction and convection. Consequently, a person seated close to a fluorescent lamp will feel perhaps only one-fourth as much heat as he would from an incandescent lamp producing the same degree of light. This coolness feature is an important consideration in air-conditioned inclosures from which all surplus heat has to be removed. Fluorescent lamps, by reason of their shape, have a far larger surface area than incandescent globes that concentrate the light. In short, they offer less glare and are therefore easier on the eyes.

The fluorescent lamp fortunately came along on the eve of a period of great industrial activity and is helping to speed up our war-production efforts by providing better illumination in shops and factories. Until recently, the intensity of the light in the average industrial plant was around 10 foot-candles—a foot-candle being the amount of light received on a surface one foot away from a standard 1-candle-power light source. By comparison, the so-called "ideal" light under a shady tree on a sunlit day has an intensity of 1,000 foot-candles! By using fluorescent

lamps, many factories have raised the level of their general illumination to 40, 50, and more foot-candles, and for close work some of them even provide 100 foot-candles. This improved lighting has increased accuracy, reduced spoilage and accidents, lessened fatigue of employees, and resulted in other benefits. Lost time is cut to a minimum, as it is no longer necessary to take careful work to a window at intervals to inspect it. Fluorescent lamps have proved a boon to old factories because most of them would have been unable to add any considerable number of incandescent lamps without expending time and money to rewire so as to supply the additional current required for more light.

Although the cost of fluorescent lamps has been coming down steadily as production has increased, they still are considerably more expensive than incandescents and, consequently, are so far used mainly where there is need for a great deal of light or for a certain quality of light. Offsetting this first cost, however, is higher efficiency and longer life. Most sizes will burn 2,500 hours, but some 3,000 hours, before requiring replacement. Their tubular shape permits installing them in confined places not suitable for incandescent lamps. On the other hand, it does not lend itself so well to making up attractive table and floor lamps for the home, although much has been done recently towards improving fixtures and luminaires.

As the name of the new lamp implies, advantage is taken of the phenomenon of fluorescence that characterizes some substances. Such materials glow under ultraviolet light. Literature records that more than 300 years ago a cobbler in Italy found a stone that shone brightly in daylight. He was suspected of being a magician. The principle of fluorescence has been known for a long time, but a practical means of employing it as a source of light was not discovered until about ten years ago. Most substances that absorb light transform it into heat, but a fluorescent material converts invisible ultraviolet light partly into visible light. This takes place because the molecules of the fluorescent substance vibrate in such a manner as to change the short ultraviolet wave lengths into longer wave lengths that can be seen. Someone hit upon the idea of coating the interior of a glass tube with a fluorescent powder and passing ultraviolet light through it. And so the new lamp was born.

The ultraviolet radiation that activates the coating is a mercury arc. It is started by first heating coiled tungsten-wire electrodes at each end of the tube and then by automatically breaking the circuit through the electrodes, whereupon the current flows through mercury vapor inside the tube. As mercury is liquid at ordinary temperatures, a small volume of argon gas is included in the tube to make starting easier. The electrodes are coated with an "emission" material that has the property, when heated, of freely emitting electrons, which are necessary to carry the current that passes through the vaporized mercury. Each time the lamp is turned on, a small quantity of the emission material evaporates, and when all of it has been dissipated the lamp will alternately flash on and off and must be replaced. It is because of this that fluorescent lamps are not recommended for intermittent service. The fluorescent powders, known as phosphors, are applied to the inside walls of the tube by a process of liquid washing. The coating must be thin, yet even, so that there will be no excessive absorption of light.

Because the fluorescent bulb is essentially an arc light, a regulating device is required to prevent the current passing through it from building up to damaging proportions. Therefore, each lamp is equipped with an auxiliary ballast unit,

**LAMP REPLACEMENT METHODS**

Since large numbers of fluorescent lamps are often used in single establishments—running into the thousands in some defense plants, the problem of replacing those that fail is at times a big one. Life-expectancy curves, similar to actuarial data for persons, have been drawn up for the various kinds and sizes of lamps, and from them the maintenance engineer can gain a fairly definite idea as to when replacements will be heaviest. Stationary fixtures can be reached by ladders or by movable platforms, or installed so that they can be lowered for cleaning or making changes. The means of access should be chosen after careful study to determine the most suitable and economical type. The lamps in the picture above are in hangers that can be individually lowered to the floor. At the left is shown an automatic telescoping tower used in an auditorium where the lights are mounted close to the high ceiling.

consisting of a choke coil, to limit the current to the designated rating of the lamp; with an automatic starter switch that closes the electrode circuit when the lamp is turned on and then abruptly breaks it to induce a high voltage across the electrodes to start the arc discharge; and with a condenser. These units are small enough to be placed beneath the lamp reflector or in the base upon which the lamp sockets are mounted.

The fluorescent lamp is sturdier than the filament type and is not easily damaged by shock. However, its efficiency is affected by cold because it causes the mercury-vapor pressure to drop below the desired level. Present lamps operate dependably down to 50°F. When the air temperature falls to freezing, the light output is reduced to about 60 per cent of normal. They range in size from a 4-watt bulb 6 inches long and ⅝ inch in diameter to a 100-watt bulb 60 inches long and 2⅛ inches in diameter. When they were introduced to the public in 1938, only the 15-, 20-, and 30-watt sizes were available. In 1939, a 40-watt bulb, equal in light output to a 100-watt incandescent, was brought out and greatly boosted the acceptance of fluorescent lamps for general lighting service.

The new bulbs come in white, soft white, daylight, and five colors: green, blue, pink, red, and gold. The light given off by the standard daylight lamp is an approximate of the average noon daylight in Washington, D.C. It is close enough to daylight to serve in lieu of it for most industrial and commercial purposes. It enables one to distinguish readily between dark blue and black, but cannot be used for exact color matching. The light from the soft-white lamp is warmer in hue than that from the white lamp because it is richer in red tones and subordinates the yellow-green light. Because of this it is more flattering to the skin than the white lamp and is more acceptable in homes and in shops catering to women. The light output for uncolored lamps having the same rating varies with the type, the order being white, daylight, and soft white. To obtain colored light from an incandescent lamp it is necessary to stain the glass or to use a colored screen. Fluorescent colored light, on the other hand, is colored in itself and, consequently, is more efficient.

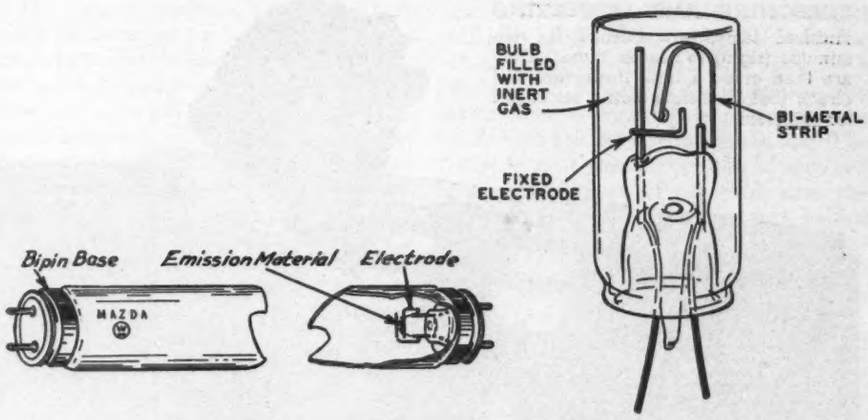
Fluorescent lamps are designed primarily for service with alternating current, but they may be operated with direct current by using special, less efficient auxiliaries. As the 60-cycle alternating current commonly used reverses its direction of flow 60 times a second, there is a recurring zero point at which no current flows. Because of this, fluorescent lamps have a slight stroboscopic or flickering effect. This is largely overcome by arranging two tubes side by side and operating both from a single lead-lag ballast unit. When the phosphor tube coating is phosphorescent, it continues to glow long enough to provide a carry-over of light between cycles. The phosphorescent qualities of the materials used vary greatly, the phosphor in the green lamp having the highest carry-over and that in the blue lamp the least.

Fluorescent lamps are related to the new blackout lamps that have become important in connection with lighting hazards, shelter entrances, etc., during air raids. In both of them, invisible rays are created by a mercury arc, but in the case of the blackout lamp the fluorescent material is on the object to be discerned instead of on the inside of the bulb. The invisible-light lamps are being put to numerous uses, some of which border on the spectacular. With a small portable unit, a military map dusted with a phosphor can be studied in the dark. Some laundries mark clothes with dyes that are invisible in ordinary light but show up under the checker's ultraviolet lamp. A Chicago hospital initiated a system of marking new-born babies in a similar manner to prevent mix-ups in identity. With such a lamp, margarine can be told from butter; chicory can be detected in coffee; and the age of eggs can be told, all through color

gradations. Because one glue varies from another in fluorescent effect it is possible by means of ultraviolet light to detect envelopes that have been opened and resealed. In the same manner, forgeries can be discovered through different color reactions of the original ink and that used for the alterations. Fungus growths that infect plants and bacteria that cause diseases in humans in many instances exhibit characteristic colors that permit them to be identified under a fluorescent microscope. The natural fluorescence of certain minerals makes the ultraviolet lamp an effective instrument in the prospector's hands. Tungsten, now in demand, is sought with its aid. At Franklin, N.J., the New Jersey Zinc Company uses the invisible rays to check the results of the milling of franklinite zinc ore, the grains of which show up readily in mill tailings when so irradiated.

To increase its facilities for making fluorescent lamps, the Westinghouse Electric & Manufacturing Company erected at Fairmont, W.Va., last year a $3,000,000 factory with a capacity of 50,000 units daily. Its production supplements that of the company's older plant at Bloomfield, N.J. Adjoining the Fairmont establishment there is now under construction a $1,800,000 plant that will supply the former with glass tubing and also manufacture glass for incandescent lamps and for electronic devices. It will have an output of 10,000 tons a year and will employ 600 persons.

Fairmont was selected as the location for the new lamp factory because of its numerous advantages. When in operation, the glass plant and the lamp works together will consume more than 40,000,000 cubic feet of fuel gas monthly. This requirement will be met by natural gas piped from a nearby field and also from Kentucky. Furthermore, Fairmont offers an ample supply of labor, both men and women, of whom the latter represent a large percentage of the employees. Transportation and electric-power and municipal water services also are adequate. The city authorities have extended the water mains to the site, which is about 2 miles from the corporate limits, and constructed a sewage disposal plant to handle the factory wastes.




**FLUORESCENT-LAMP CONSTRUCTION**

At each end of a tube is an electrode in the form of a small coil of wire. These electrodes are coated with a material that has the property of freely emitting electrons when heated. Electrons are necessary to carry the arc current through the vaporized mercury in the tube. The inside of the tube is coated with a fluorescent powder, called phosphor, which transforms the short ultraviolet-light waves into longer, visible waves, the color of which is determined by the kind of phosphor used. Operation of the lamp is started by a glow switch (right). It is inclosed in a small glass bulb and consists of two electrodes, one of which is a bimetallic strip. When voltage is applied, the current creates a spark between the two electrodes and the heat that is generated causes the strip to bend and to make contact with the other electrode. Current then piles up in a ballast reactor in the end of the tube, and when the bimetallic strip cools and the contact is broken the high-voltage surge jumps the long gap from one end of the tube to the other and the lamp is lighted. All this takes only a second or two.

**AIR-CURTAIN DOOR**

Dust plays havoc with the tubes if it gets into them, so elaborate precautions are taken to exclude it from the manufacturing plant. In addition to windowless construction, complete air conditioning, and air locks on the doors leading outside, some of the doorways within the building are provided with air curtains. A sheet-metal hood on one side of each of these doorways is connected at the top to an exhaust fan that draws the air upward and discharges it through a pipe extending through the roof.

The huge main building of the lamp plant, measuring 224x880 feet, ground dimensions, is windowless except for a small section given over to a cafeteria and offices. This blackout type of construction was adopted primarily to aid manufacturing, rather than as a measure of protection against possible air raids. Dust inside of a fluorescent-lamp tube is ruinous, cutting down its efficiency if not rendering it inoperative. Accordingly, every precaution is taken to exclude it. In addition to the absence of windows, the doors in the factory through which raw materials and completed lamps are moved in large quantities are of double construction, with an air lock between them. Doorways between the manufacturing departments and the shipping and receiving rooms are fitted with air curtains—a continuous current of air drawn across each opening to bar the entrance of dust. The entire structure must, of course, be air conditioned which, in this instance, means tempering the atmosphere in each of the different zones so that the desired temperature is closely maintained despite widely differing conditions due to various processing operations.

The cooling of the air calls for large quantities of water, and this is obtained from a source that is out of the ordinary. About 1,800 feet away from the building there is an abandoned and sealed coal mine containing, it is estimated, 244,000,000 gallons of water that never rises above

**SEASONING AND INSPECTING**
Finished lamps are burned for ten minutes (right) to season them. They are then given a final inspection and check (below) before being packaged for shipment.

a temperature of 56°F. From this vast reservoir it is pumped at the rate of 3,600 gpm. to the plant, where it serves to cool city water and is then returned to the mine through a bore hole. The cooled city water is sent through the cooling coils of the air-conditioning system. Because of the great volume of gas burned in the manufacturing process, the air circulated in the lamp-making area is all taken in from outside. The proportion of fresh air to recirculated air in the other parts of the factory can be regulated as desired. All outside air is cleaned by passing it through Westinghouse Precipitron cells, which remove 90 per cent of the air-borne particles. It is further treated with sterilamps to kill bacteria.

The plant is located on sloping ground overlooking the Monongahela River. When work was started, one side of the site was 150 feet higher than the opposite one and two ravines, one 90 feet deep, cut through the tract. By moving 340,000 cubic yards of earth and rock, it was transformed into three level benches with a difference in elevation of only 35 feet between the upper and the lower one. What was formerly the deepest section of one of the ravines is now a parking lot. Within five months after the initial steel work was erected, were completed the main building —which has five acres of floor space under one roof—and seven smaller auxiliary structures, along with paved roads, a railroad siding, water reservoir, parking lot, and other facilities.

The manufacturing building has a central aisle, 100 feet wide, with a 60-foot aisle on each side. Under normal conditions, a 6-weeks' supply of both raw materials and finished lamps is maintained and stored in one end of the structure. During their conversion into lamps, the raw materials travel down the side on which they are received; turn and cross the building; and move back up the other side until, in finished form, they reach storage. Floors in the production areas are of emulsified asphalt; in the kitchen and in rooms where flammable solvents are handled they are of sparkproof and acidproof Hubbellite. Fifty-one hundred 40-watt fluorescent lamps illuminate the factory to an intensity of 40 foot-candles, the total lighting load being 225 kva., or the equivalent of 1.3 watts per square foot. Twin-lamp, open-end luminaires are hung end to end to form continuous light troughs spaced 51 inches apart at heights of from 10 to 13 feet, depending upon the requirements of individual departments. The cafeteria has windows and is equipped with incandescent lights, both being designed to rest the eyes of the workers after being under the fluorescents. Electric current comes into the building over two 66,000-volt lines and is reduced to 6,600 volts by two outside transformers. Inside the structure, six transformers step the voltage down to 120, three transformers normally being connected to each feeder line. If a network cable fails, half the transformers will carry the plant load until the others can be switched over. Should one break down, protecting and limiting devices will isolate it and the remaining ones will carry the load. As a result, any section of the network, or even an entire circuit, may be disconnected without enforcing a shutdown.

Compressed air enters importantly into the making of fluorescent lamps and is used at several different pressures, ranging from a pound or less up to 50 pounds per square inch. Most of these needs are supplied by Ingersoll-Rand machines of two different types. There are two Class ES, single-stage, horizontal units, each with a capacity of approximately 500 cfm. at 50 pounds pressure and belt driven from a 75-hp. motor. Before going to a receiver and thence into the distribution lines, the air passes through an I-R aftercooler to remove surplus moisture. The compressors furnish air at 50 pounds pressure for service in connection with gas-fired machines that flow glass around metal parts in making up the end pieces of the lamp assemblies. They also supply 50-pound air for cleaning lamp parts and factory machinery. Some of the output is reduced to 30 pounds pressure and employed to run air motors that drive agitators used in mixing flammable or explosive fluids.

Three Type MM 10-stage Motorblowers, each having a capacity of 550 cfm. and operated at 3,500 rpm. by a 25-hp. motor, furnish air at a maximum pressure of 5½ pounds for three services. One unit supplies combustion air to the gas burners of several furnaces required in process work. Another one provides air for handling fluid phosphors during the coating of the interiors of the lamp tubes, which will presently be described, and also furnishes a blast of air for cooling the bases of the lamp tubes after they have been cemented into place with the aid of heat. The third machine serves as a spare.

The first manufacturing operation is the coating of the insides of the glass tubes with fluorescent materials. Prior to this work, each tube is cleaned on a machine that runs a revolving brush through it while suction is being applied at the opposite end to withdraw any dust or lint present. The phosphors are made up in the plant by mixing powders prepared at the company's Bloomfield factory with nitrocellulose or some other organic solvent. The composition of the powders varies

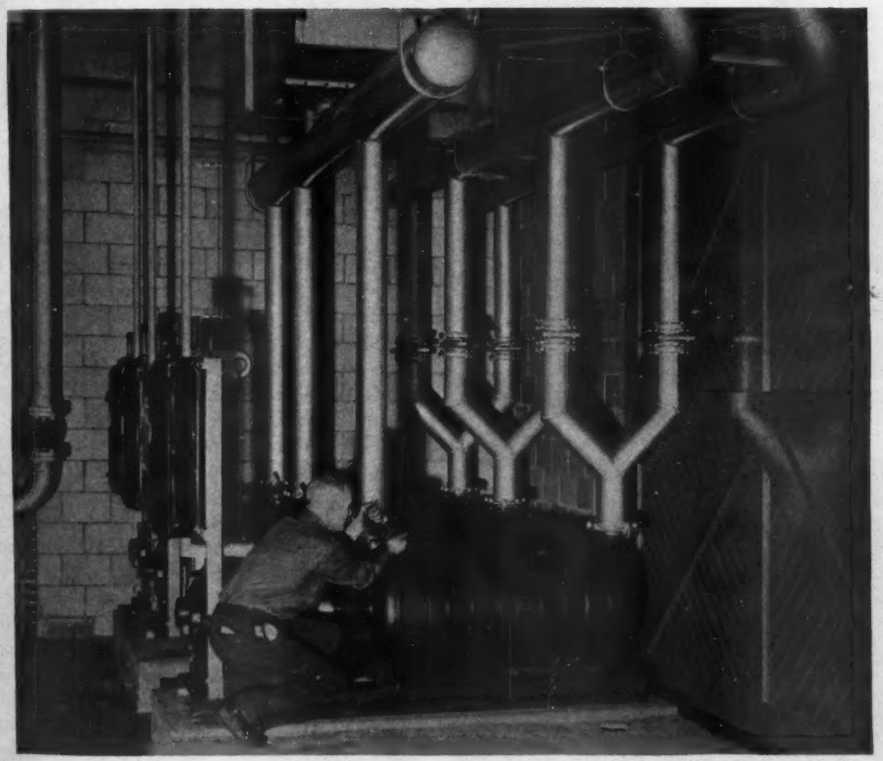
according to the color of the light to be produced by the finished lamp, but all of them are salts of metals. Some of those in use, and the characteristic colors they impart to the light, are: zinc silicate, green; calcium tungstate, blue; cadmium borate, pink; zinc-beryllium silicate, yellowish white; and magnesium tungstate, bluish white. All the phosphors are white when not exposed to ultraviolet radiation, the same as the unlighted fluorescent lamps. The only exceptions are the gold- and red-light sources, which are coated with an appropriate pigment before the phosphors are added. The pigment layer absorbs the radiations which are not desired in the lamp.

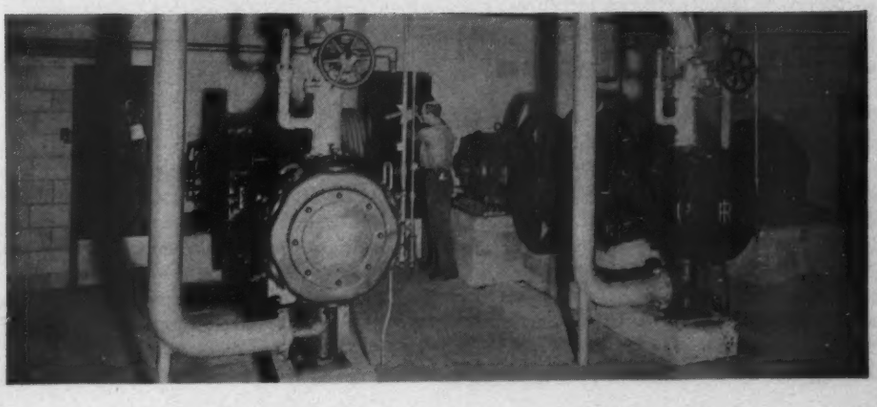
The phosphor powders are blended to obtain the exact colors wanted and to keep them uniform. This is done in Abbe 100-gallon tube mills, of which there are six. They are then mixed by means of air-driven agitators with the proper solvent to form the liquids used in coating the tubes. The liquid is applied with the tubes in the vertical position, being forced up inside of them by compressed air. After they are drained of any excess liquid they are dried to remove all organic matter. This is done in gas-fired furnaces through which a current of air is passed to carry away the vapors. The tubes are heated to the soft point during this operation and, if they have been received from the glass factory a little out of line, they will straighten out as they travel through the furnace on rollers. The dried tubes and mounts are now ready for assembly.

The mounts are the end pieces, including the lead wires, with the electrodes and the emission material in place. The whole is later encircled at one end by a metallic ring and base piece from which protrude the two pins that serve to seat the tube in the sockets of the luminaire. Girls insert the lead wires through a funnel-like glass opening and seal them in position by flowing glass around them. This is done on circular, horizontally revolving machines, of which there are thirteen—one for each size of tube made. Each machine has 24 stations. When a mount is placed on one of these stations, a natural-gas flame, with the addition of oxygen at the point where extra heat is required, is played on the glass with the aid of compressed air. The piece is next passed through a gas-fired annealing furnace to relieve strains; the coiled-tungsten electrodes are spot-welded on the lead wires; and the emission material is put on the so-called "hot" electrode, which is at the end of the tube where the current enters.

When the mounts are made up, a small glass tube is left extending through one of them. This provides an outlet for the air which is removed from the interior of the tube prior to injecting the all-important mercury that serves as the current conductor. This is done on a revolving machine, in which the tubes rest in the vertical position. The opening is capped by a fixture, and vacuum, induced by a pump in the base of the machine, is applied. Virtually all the air is exhausted, after which mercury is injected in doses of 30 milligrams each. The amount depends upon the size of the tube, a 40-watt tube receiving three doses, or 120 milligrams. Following this, the air is again exhausted; a small amount of argon gas is injected; and the small opening is sealed with electrically generated heat. The final operation consists in baking the metallic circular bases on at each end with cement, the lead wires at the hot end being soldered to the pins that hold the lamp in the sockets of the luminaire. The bases are then cooled by means of a blast of compressed air.

The finished lamps go to a seasoning rack where each one is burned for ten minutes, during which period it is tested for color, amperage, voltage, and power output. They are now ready to be turned over to a staff maintained at the plant by the Electrical Mazda Service, an independent organization of the electrical trade. Two lamps are taken at random from each 24 that go to make up a box packed ready for shipment, and are tested. Placed on wooden skids that facilitate handling and can be stacked to save space, the boxed product is carried to the warehouse zone for either storage or immediate consignment.





**COMPRESSED-AIR SUPPLY**

Compressed air, at pressures ranging from a pound or less to 50 pounds per square inch, performs a variety of services in connection with the manufacture of fluorescent lamps. The single-stage, straight-line machines shown at the right furnish air at 50 and 30 pounds pressure for lamp molding, for cleaning lamp parts and equipment, and for agitating liquid phosphors. Three Ingersoll-Rand Motorblowers (above) each provide 550 cubic feet of air per minute at a maximum pressure of 5½ pounds. This is used for the combustion of gas in furnace burners, for forcing liquid phosphors up inside the lamp tubes, and for other purposes.

# The Bronx Zoo Goes Modern

*Robert G. Skerrett*

Photos from New York Zoölogical

WHY is a zoo? Can existing ones render better service to the public and to the living creatures confined there? These questions have no doubt been asked time and time again both by the curious and the critical. The New York Zoölogical Society has elected to provide fitting answers to them through an impressive program of modernization that is now underway in the New York Zoölogical Park—better known as The Bronx Zoo—which annually attracts 3,000,000 to 4,000,000 visitors ranging from childhood, through adolescence, to more or less advanced maturity. These people are bent upon recreation, entertainment, and enlightenment, depending upon the promptings that take them there.

To most of us, the average zoo seems in the main to be just an aggregation of wild animals gathered from many parts of the world and confined where they can be seen with safety, the inmates being restrained in cages or behind bars that greatly limit their natural freedom of movement. Such an arrangement is neither fair to man nor beast from an exhibition point of view. The New York Zoölogical Society is scrapping these limitations by bringing about strikingly changed conditions at The Bronx Zoo.

To make more understandable what has been going forward there during the last two years one should know that the New York zoo was first opened to the public in November of 1899 and occupies a scenically fine wooded expanse of 240 acres in what was at the start a wilderness section of South Bronx Park. Between that time and 1922 well-nigh all the major buildings originally projected were erected; and as the animals brought together there increased in variety and size, The Bronx Zoo attained an outstanding position among the great zoos of the world. And then, for the succeeding eighteen years, little if any change was made in the buildings or in the methods employed in housing or confining its truly splendid collection of animals—some of them being the finest of their species. Cages, caves or grottoes, and some more or less restricted reservations of conventional types were relied upon to hold the exhibits: all good, but undeniably susceptible of improvement.

Such was the status at the beginning of 1940, and then came an awakening described by Fairfield Osborn, president of the New York Zoölogical Society, as "A

healthy restlessness has come upon the officers and staff of the Society. We are working upon plans for the future development of the Zoölogical Park . . . We are convinced that new techniques can and should be employed in maintaining and exhibiting our unique collection of living animals." There are the best of reasons for this newer attitude towards the creatures on display and their value in enlightening the public.

The animals of today are descendants of very remote forebears, and they reflect the influences of amazing migrations and the changes wrought the while by their kinds. One purpose of the program of modernization for The Bronx Zoo is to bring this lesson home to us. As Mr. Osborn explains: "There was a time, once, when a man could have walked from Africa, northeasterly across upper Asia, trod the land bridge to North America, and come finally to South America. . . . . Many different kinds of animals made long intercontinental journeys, either coming here from Africa or Asia or leaving here to find new and greener valleys. Of them all, the elephant was one of the most untiring and undaunted. It is believed that its prehistoric ancestors originated in Africa. If this is true, majestic, ancestral bull elephants must at various times have trumpeted from the hilltops there, gathered their cows and young bulls around them, and started the great journey which ended only when their descendants had come down the Hudson Valley. Some of those mastodons even continued to the southern hemisphere, where their skeletons have been found as far south as Argentina. But it was not all one-way travel. The camel family, as well as the ancestors of the horse, originated in America and spread out to Asia and Africa from this continent."

It is an established fact, proved by fossil remains recovered from the White River Badlands of southwestern South Dakota and parts of neighboring Nebraska and Wyoming, that a large and highly developed form of the rhinoceros type once existed on this continent, but whether it originated here or arrived from some other continent by way of the land bond between America and Asia—of which the Aleutian Islands bordering Bering Sea are surviving vestiges—must be left to speculation. The thing of immediate moment is that the traces of world-wide treks during remote ages have helped to explain the distribution of animals as we find them today in different parts of the world. And because Africa was the birthplace and later the refuge for many forms of animal life, the New York Zoölogical Society has drawn upon the Dark Continent for the first of its new order of continental exhibits—the African Plains of The Bronx Zoo.

The African Plains comprise about five acres of rolling land, formerly part of the old bison range, in the southeastern corner of the zoo. The work of transformation started about two years ago, and was

**BRONX-ZOO RESIDENTS AND VISITORS**

The entrance to the African Plains (top-center) is flanked by stockades on which are legend-maps that tell the story of African wild life from the Age of Reptiles down to the present. The other pictures, starting at the upper left and viewed in counter-clockwise order, show a few of the many interesting specimens in the zoo: a zebra, flamingos, a giant panda from China, and waterbucks.

**LIONS ENJOY NEW HOME**

**The 5-acre section of the park in which animals from South Africa are kept approximates closely the terrain and general appearance of their native haunts. These pictures show some of the lions in one part of that enclosure and a stretch of the moat that forms a naturalistic barrier and prevents their escape.**

completed in May of 1941. Extensive excavating with rock drills, power shovels, and other present-day facilities preceded the labors of the landscape architect and his cohorts. Skillful planning and carefully chosen plantings of domestic trees and shrubs, suitably trimmed or topped to produce an African silhouette, have provided a setting for lions and other mammals and birds native to the Dark Continent. As an official of the park has described the undertaking: "Thus we start an adventure in synthetic habitat planting."

At the northern end of the African Plains was created what is known as Lion Island—a flat rocky expanse having an area of something less than half an acre. This is now the home of a group of five young lions that were given their liberty there on Christmas Day, 1940. At first sight, there is no arresting barrier either between them and the public or between them and the other animals and running birds that have since then been given their seeming freedom on the remaining section of the African Plains. But the lions are, nevertheless, confined to their island by cleverly concealed moats 18 feet deep and 20 feet wide. The moats, with their sheer sides and water of deceptive depth, are too broad for them to leap and thus prevent them from straying. An adjoining structure of an African type offers a covered retreat for the lions when the weather becomes uncomfortably cold or wet, and it also serves as their feeding place.

Elsewhere on the plains are zebras, springboks, mountain reedbucks, lechwes, waterbucks, nyalas, an impala, a hartebeest, and a pair of wart hogs, also such African birds as paradise, crowned, and demoiselle cranes, a ground hornbill, a crested guinea fowl, a vulturine guinea fowl, a horned guinea fowl, a marabou stork, a South African ostrich, and a secretary bird. A pondlike "water hole" serves as a common center of attraction for the birds and mammals in this part of the new exhibit. The sunken wall that envelops the plains is topped by a low planting that acts as a deceptive screen for the masonry barrier, and the visitor has the thrill of looking over it toward the animals after the fashion of one on safari getting a glimpse of the creatures free on their native range.

Upon entering The Bronx Zoo from the southeastern gate one approaches the African Plains by a broad path flanked by stockades that are typical of that country and on which are hung a succession of legend-maps that graphically tell the story of the life of Africa through the ages—as far back as 100,000,000 years ago. In this fashion one can link the long-dead past understandingly with the vital present, as exemplified by the birds and mammals on the African Plains of man's making.

We are authoritatively told that "No presentation of this kind has even been attempted in any other zoölogical park—nor any really similar one in any museum." It is a pioneer departure in zoölogical-garden planning, and is intended to provide the opening chapter in a miracle story of the distribution of different species of animals among the various continents, their evolution, their interdependence, and their social relationships. In carrying out this program the aim is to bring the animals out from behind bars and to return them to surroundings much like those whence they came. A member of the Society who prefers to remain anonymous has provided the $110,000 that has made the African Plains possible.

Practically completed now is the second phase of the work at The Bronx Zoo to give some of the large creatures more elbow room and a greater measure of "home atmosphere." This consists in changes around the elephant house where, again, the pneumatic rock drill and the paving breaker were of assistance in effecting the desired transformation. Heretofore the grounds were hemmed in with heavy iron restraining fences and with but little to contribute to the happiness of the pent-up creatures or to their effectiveness as exhibits. Now the area for the elephants, hippopotamuses, and rhinoceroses are commodious, and pools lend naturalness to the scene. The several reservations take the form of sloping pits, with masonry walls high enough to confine the animals and, topped with low marginal hedges, to give the spectator the impression of an absence of intervening barriers. The creatures will enjoy more opportunities for "self-expression."

The old raccoon exhibit has been aban-

doned under the program of modernization, and the animals have a new home, on naturalistic lines, along one of the streams flowing through Bronx Park. In addition, the wild-fowl pond, where thousands of wild black ducks and Canada geese spend each winter, has been partly provided with a shore-line masonry retaining wall and replanted. This gives the public more space and a better chance for closer observation of the winged visitors. Perhaps one of the most interesting of the recent innovations is the Children's Zoo, built on a juvenile or reduced scale, which contains both domestic and pet wild animals that have their retreats in houses harmonizing with favorite storybook tales. The object is to bring the young ones of man and beast into intimate and friendly relations and so lay the foundation for a better and lasting reciprocal understanding. A riding track also has been constructed where children may be carried, weather permitting, by elephants, camels, llamas, or alpacas.

Following the abandonment of the aquarium at Battery Park on the southernmost tip of Manhattan, the New York Zoölogical Society, charged with the management of both The Bronx Zoo and the aquarium, undertook to create a new home at the zoo for fresh-water and tropical salt-water fishes. For this purpose is being used one side of the lion house. There, as at the old location, compressed air will serve to aerate the water in the display tanks, at times to pump water from the tanks by air lift, and to clean the filter beds through which the water supplied the tanks must be repeatedly run.

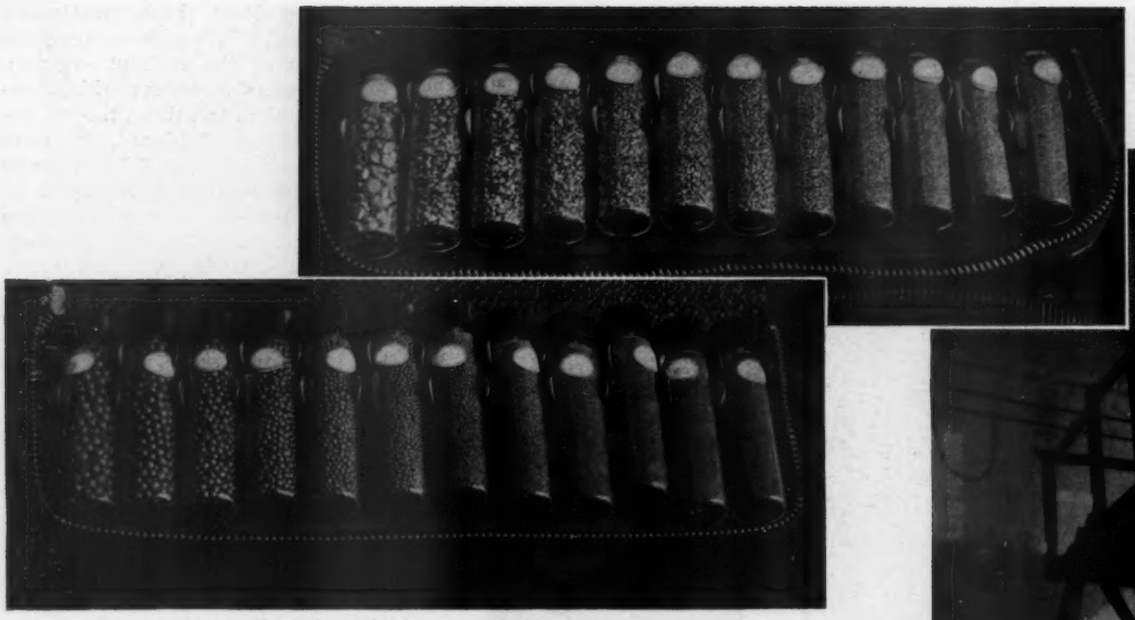
Until of late the public was not allowed to feed the animals. Today, they are permitted to do so, and properly chosen foodstuffs in packages are obtainable at a modest price from conveniently placed self-vending machines. This is one more means of stimulating interest in the zoo's denizens. Further, amateur photographers did not have the pleasure of making snapshots in the past: now, on the contrary, they are free to take pictures, and are even encouraged to do so through annual photo contests. For the convenience of the increasing number of visitors, walkways and paths have been considerably widened while some routes have been changed, necessitating recourse to a portable compressor to furnish air for operating rock drills and paving breakers. One might really say the zoo has been undergoing face-lifting and has even received a new make-up, because hitherto dark-green cages have been brightened with touches of rainbow tints and some of the animal housings now glory in tans, blues, and other gay colors.

The work of maintaining the zoo is a manysided problem, both structurally and aesthetically. The task is largely the responsibility of the resident engineer. He has a group of workshops as his primary base of action, and these, too, are being redesigned and reëquipped. In one of them is installed a 2-stage, 5-hp., Type 30 compressor and receiver delivering air at 100 pounds pressure to various points through branching lines for cleaning, inflating tires, operating pneumatic tools, spray-painting, and redecorating trucks, buses, tram-trains, furniture, and other fittings and facilities to keep the garden looking spick-and-span. Beyond the immediate limits of the shops, compressed air is supplied for different services by a Mobil-Air 2-wheel unit with a capacity of 105 cfm. that can be whisked around where needed within the reservation.

During the eighteen years in which The Bronx Zoo remained somewhat static, newer zoos in this country adopted moated and barless inclosures and out-of-door exhibits. The Bronx Zoo has not only caught up in these particulars but has jumped again into the forefront and is intent upon keeping that lead. In a studied effort to link the past with the present and so intensify interest in the fascinating age-old story of wild animals and their evolution, the New York Zoölogical Society has done a splendid thing in creating the African Plains exhibit, and promises still other unique educational attractions.

**COMPRESSED-AIR WORK**

Rock is at or near the surface throughout the Bronx Park area, and all the moats, trenches, and other excavations had to be drilled and blasted. Two of these pictures show wagon drills and Jackhamers engaged in that work. The other view is of an Ingersoll-Rand, 105-cfm. Mobil-Air compressor that supplies air for operating drills and pneumatic tools. It can be moved quickly from point to point in the general maintenance of the park.



**STEEL ABRASIVE AND ONE OF ITS USES**

Behind the concrete walls in the picture at the right, streams of molten steel flowing from a cupola are intercepted by steam jets that break them up and hurl the metal through the air, causing most of the particles to assume spherical shapes of varying sizes. The myriads of globules make a brilliant pyrotechnic display and then fall into water that chills and hardens them. From the pit in the bottom of the vat they are elevated and passed through a cylindrical heat-treating chamber to remove brittleness and impart toughness. The shot is graded by screening into sixteen sizes, and irregularly formed pieces are crushed into twelve sizes of grit. The bottles in the sample cases (above) show the range of commercial sizes of the two products. These abrasives have many industrial applications, among them the use of shot as the cutting medium of Calyx core drills. A machine of this type is pictured at the lower right putting down a 36-inch hole in the floor of the excavation for the foundation of Norris Dam in Tennessee. Geologists descended into the holes so made to examine the rock in place.

THE dictionary defines an abrasive as any substance used for abrading; that is, for grinding, polishing, or any other operation that involves the wearing away of a surface by friction. Abrasion depends upon the relative hardness of two materials, and if an abrasive is to do its work effectually it must be harder than the substance being abraded. Inasmuch as materials of all degrees of hardness are cleaned, ground, and polished in the course of their manufacture, abrasives themselves are of many different hardnesses. So that there might be available a standard of comparison, F. Fohs made up a scale of hardness for minerals in 1820, and it is still in use. He arranged ten well-known minerals in the order of their hardness and numbered them from 1 to 10, talc being the softest and the diamond the hardest. The diamond is so much harder than any other known natural material that nothing else even closely approaches it. This is shown by the fact that the gap between it and corundum, which is next to it in the scale, is greater than that between corundum and talc, which are separated by eight numbers. Ordinary metals are soft in comparison with the diamond, and even with some other metals—a steel knife or file being scratched by quartz, which is No. 7 in the scale.

The demand for abrasives for industrial use has increased enormously in our present mechanical age, and various synthetic materials have been developed in order to meet it. Best known among these is silicon carbide, but carbides of boron, tantalum, tungsten, and other metals also are important. With respect to hardness, they fall between corundum and the diamond. Abrasives come in different forms, depending upon the nature of the service to be performed. Familiar to all of us are the solid kinds such as grindstones or whetstones, which may be a block of natural stone or composed of bonded particles of natural or artificial materials. Loose powders are widely employed for grinding and polishing, or granules may be glued on paper or cloth for convenient use. Diamonds, in the form of carbonadoes or borts, are frequently set in a metallic matrix to make rotary drill bits.

The metal-working industries, especially foundries, have long utilized abrasives for cleaning castings and other products. The traditional material for this purpose was sharp sand, preferably beach sand, containing a high percentage of silica (quartz). In the beginning, the pieces to be cleaned were placed in drums with a quantity of sand and were tumbled. This was a slow and not a very effective process, and was much improved upon when B. F. Tilghman of Philadelphia invented a method of propelling the abrasive at high velocity by means of a stream of compressed air. This was the basis of the sandblast, which came to be universally employed. In recent years it has been supplemented by machines that hurl the sand by means of a rotating element.

In the blasting process, the sand breaks down to some extent through impact with metal and collisions of the grains themselves, the amount of pulverization being greater where the sand contains a considerable proportion of minerals softer than silica. This fracturing results in objectionable dust. To eliminate this and also to obtain a more effective and a more uniform abrasive action, chilled-steel shot or grit is substituted for sand in many

# ille eel Shot and Grit

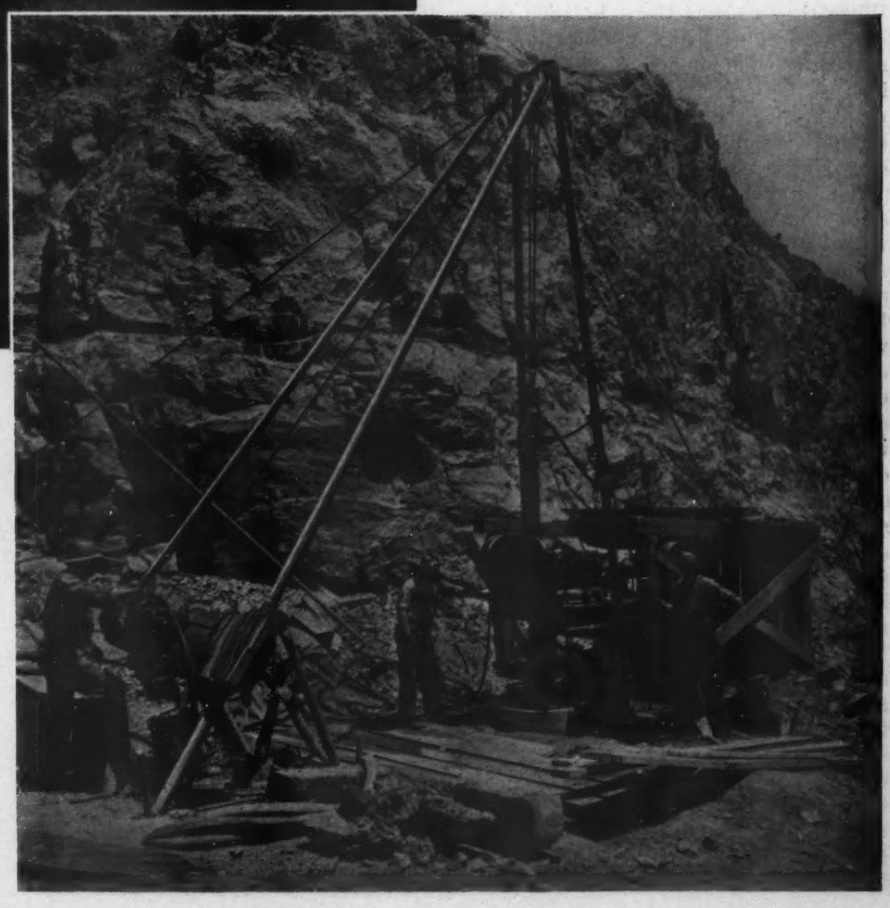
*Allen S. Park*

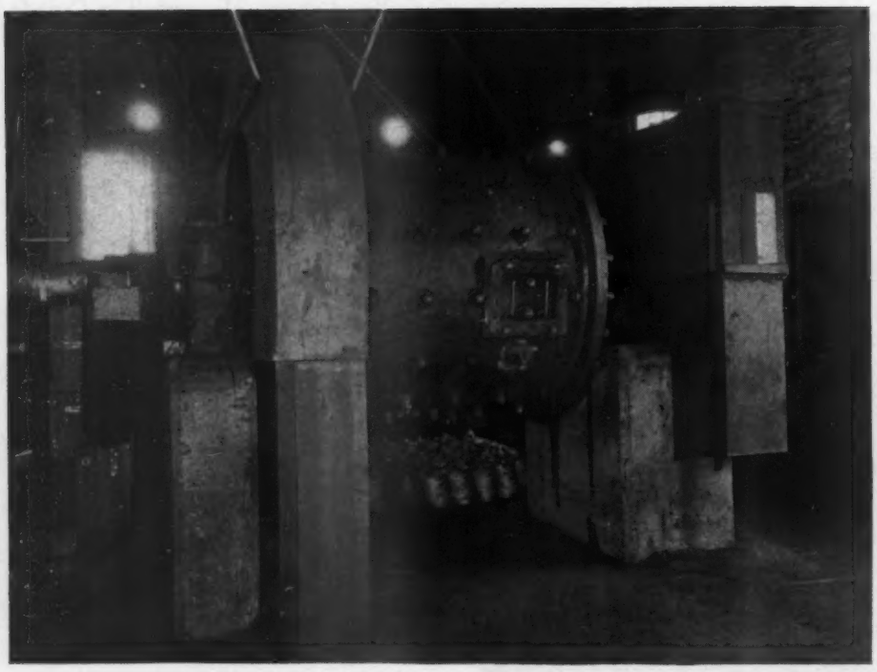
cleaning operations, especially where the class of work being done is such that it warrants the slightly increased cost involved.

One of the leading manufacturers of chilled-steel shot and grit is the Harrison Abrasive Corporation of Manchester, N. H. The president and directing head of the organization is Nathan C. Harrison, whose father, John Harrison, invented the method by which all steel shot is now made. The saying that necessity is the mother of invention was true in his case. The elder Harrison needed an abrasive that would cut stone faster than would sand, and his wife was largely responsible for putting him on the track of it.

John Harrison was a building contractor who specialized in public structures, usually of stone. He worked in Canada and the United States, and in both countries put up numerous edifices that are still in use. In those days, building contractors did not have available all the sources of materials that are now open to them, nor were there so many subcontractors to take over some of the work. It was customary for them to do the job from start to finish—to turn over to the owner the keys of the completed structure. Instead of buying stone cut to order, as is done today, he operated his own quarries; got out the rock; and reduced it to the required sizes. Then, as now, the stone was cut with gang saws, and sand was used as the abrasive for the flat blades.

Among other contracts, John Harrison took one to erect parliament buildings at Fredericton, the capital of New Brunswick, Canada. He agreed to have them finished by a certain date or to pay a penalty for each day he exceeded the specified time. Work fell behind schedule—the cause for the bottleneck being the gravity-feed gang saws that were employed for reducing large blocks of stone to usable sizes and that could not be made to cut fast enough. Noticing that her husband was worrying about something, Mrs. Harrison asked him one night what was bothering him, and he told her. She questioned him about the sawing process, and when he explained it to her she asked why he couldn't get another abrasive that would cut faster than sand. That started him thinking,





**SHOT EXPERT AND BALL MILL**

Otto Olsson (below), superintendent of the Manchester factory, is reputed to be the most experienced shotmaker in the country. In one hand he holds some shot; in the other he has one of the manganese-steel balls that are used to make steel grit by tumbling irregular fragments in ball mills such as the one pictured at the left.

and he mulled the problem over in his mind most of the night.

The following morning he stopped at the machine shop on his way to the stone-dressing sheds and saw some oil-soaked iron filings on the floor. The idea came to him that these might do the trick, and he told the foreman to burn off the oil and to send them to the saw house. When they reached there, he tried them out, and, much to his gratification, the rate of sawing jumped from 1½ to 16 inches an hour. He continued using the new abrasive, completed his contract ahead of time, and collected a bonus instead of paying a penalty.

For several years thereafter he took short-time contracts and made out very well, thanks to what he had discovered. As his own machine shop produced only a small quantity of filings, he began buying them wherever he could; but such shops were not numerous, and he soon found it difficult to obtain the material. He then set about providing a substitute, and ended up with a much superior product, namely, chilled-steel shot. The method he devised for making it was ingenious, yet simple. It consisted in flowing a small stream of molten ferrous metal out of a cupola, breaking it up with a jet of steam, and allowing the globular particles to fall into a tank of water to chill them. Harrison established his factory in Canada in 1874, and patented his process in that country. The pellets produced varied in size. The larger ones were in demand by the stone-working industry, but the smaller ones were of no value there. It was around that time that Tilghman invented the sandblast and introduced it into foundries. He learned of Harrison's steel shot and began purchasing all the smaller sizes made by him. He continued this for several years; then took out a patent on the process in the United States and began manufacturing his own shot.

Afterward, Harrison went to England; patented his method there; and started producing shot at Middlesbrough, which was close to iron mines. Two years later, after getting the business well established, he set out for the United States to visit his family. He became sick suddenly and died on the steamer *Etruria* during the crossing. His widow was left with five sons, all minors, of whom Nathan was the youngest. Undaunted by this turn of events, she moved the family to England; carried on the business under the direction of the foreman; and as fast as her sons became of suitable age she placed them in the factory to learn shot-making. Eventually, Richard Harrison became manager, but the mother remained abroad and Nathan, who returned to America to make his home, recalls that he crossed the Atlantic 52 times—26 round trips—to see her.

On one of these occasions he was walking through the plant and got into conversation with a young workman. Impressed by the latter's apparent knowledge of the process and by his ideas for reducing costs, he took him into his brother's office and suggested that he be made a foreman. Richard demurred, but Nathan insisted, and after considerable argument the employee was given the promotion on trial. It developed that Richard had met him one rainy night in Darlington, where he and Mrs. Harrison had gone to attend a lecture. The young fellow came up to them at the railroad station where they were awaiting a train that was to take them back to Middlesbrough, a distance of 12 miles or so. It was raining, and the English lad was none too warmly clad and his shoes were obviously the worse for wear. Politely, he begged the couple's pardon and asked them if they had enjoyed the discourse, saying that he had seen them there. Interested in the attendance of one of his apparent poverty at the lecture, they questioned him and learned that he lived in Middlesbrough and that he intended walking back there that night. They further learned that he was out of employment. Richard Harrison prevailed upon him to accept train fare home and told him to come to see him the next day. That was how he happened to get his job.

Following his promotion, the workman made good and continued the courses in night school which he had been taking since he obtained employment. He saved his money, and one day he came to Richard with an offer to buy the business. He said he could pay half the purchase price in cash. The transaction was made, and the new owner ran the plant successfully for a number of years; then he sold it and became interested in politics as a member of the Labor Party. He is now a member of Parliament and a polished speaker who has several times in recent years flown the Atlantic to address American Rotary clubs, receiving all his expenses and a

sizable fee besides. His name is Alfred Edwards, and he is still in his early forties. In reciting this chain of events, Nathan Harrison stressed the point that even in England, where social strata are more clearly defined than here, it is possible for an individual of lowly birth to rise to affluence and power.

Upon his return to America, Nathan Harrison sold shot produced in the English factory. Despite the fact that it was subject to $20 a ton duty, it successfully competed with the domestic product, and as much as 4,000 tons of it was bought here in a year. After disposing of the English plant, Richard came back to this country and established a shot factory in Amesbury, Mass., in 1918. Nathan continued to deal in abrasives, doing business for many years in Boston under the name of the Harrison Supply Company which he had formed in 1900. He handled various natural-stone abrasives and made trips to many parts of the world to arrange for stocks of them. He also sold shot and grit made in his brother's plant, and did so even after it changed ownership in 1922.

In 1938, Nathan established the Harrison Abrasive Corporation in Manchester, and the first product was turned out on August 15 of that year. Starting with no customers, but with an intimate knowledge of the business and a wide acquaintance among abrasive users, he has been able to steadily increase the output and is now making 1,200 tons monthly. At the outset, he enlisted the counsel of Dr. Albert Sauveur of Harvard University, one of the country's outstanding metallurgists. Upon Doctor Sauveur's advice he adopted the policy of carefully selecting the ferrous materials so as to obtain an alloy of the desired characteristics for the shot, and also that of weighing every pound of raw material entering into each melt. As a further step towards imparting toughness and strength to the shot he resorted to heat-treating.

Shot-making is a continuous process and is entirely mechanical from the time the raw product is charged into the cupolas until the finished shot or grit flows into double burlap bags holding 100 pounds each. Melting is done in a 10-ton and an 8-ton cupola, which are alternated in service from day to day. The raw metal is old machinery—known as No. 1 Textile—No. 1 Cast Scrap, and certain grades of pig iron. Weighed quantities of these and of coke and limestone are charged at intervals throughout a run to keep the cupola well filled. Slag that accumulates on the bed of the cupola is blown off through a slag spout at the rear of the cupola bottom. A great deal of this is emitted in the form of fine glass-wool filaments. These float through the air and lodge on beams and other projections, giving the eerie effect of giant cobwebs.

In line with the company policy of accurately proportioning all materials going into the cupola, the air that is introduced to aid the melting process is continuously weighed. Fortunately, this entails no difficulty, for it is accomplished automatically by the constant air-weight control on the Ingersoll-Rand Type FS Motorblower that is installed. This type of blower is designed so that there is a direct relationship between the air delivery and the power consumed by the motor. By controlling a motor-operated blast gate, situated in this case at the blower intake, a small contact-making ammeter holds the power consumption constant at any desired setting. The weight of the air delivered to the cupola is thus held constant despite variations in air temperature, barometric pressure, and cupola resistance. The blower has an inlet capacity of 4,400 cfm. and compresses the air to 1¼ pounds pressure. It is driven by a General-Electric 40-hp. motor, using 220-volt, 3-phase, 60-cycle current. In addition to the advantages resulting from weighing the air, this unit has reduced power costs because it replaces an older-style blower that was operated by a 75-hp. motor. The discharge pipe from the blower branches out a few feet away from the machine, one line extending to each of the two cupolas. By manipulating a slide gate in either branch it is possible to direct the entire blast into the cupola that happens to be in service.

After the molten metal issues from the cupola spout the stream is directed into several channels of different sizes that take off from the main one. There are six of these channels, and all or a number of them may be used, depending upon what streams are desired. The surface down which the metal flows projects over a large vat filled with water, and as the streams pour over this edge and descend toward the water they are intercepted by individual, horizontally directed jets of steam. These break up the metal into

**EVERYTHING IS WEIGHED**

To obtain metal of the exact composition for best results, everything that goes into the melting cupolas is weighed. At the right is a barrowload of scrap metal on scales. The other picture shows the Ingersoll-Rand Motorblower that supplies the combustion air. By constant air-weight control it regulates the blast within close limits and assures efficient and economical cupola operation.

glowing globules that make a spectacular pyrotechnic display as they are blown several feet through the air and fall into the water, where they are suddenly chilled and hardened. In some plants, compressed air is used instead of steam, but the latter is preferred in this case because it does not cool the metal appreciably before it strikes the water. In being hurtled through the air, most of the myriad pellets assume a spherical form. All the commercial sizes of shot, ranging from 1/32 inch down to 120 mesh, are made in one operation, as just described. It is possible to control the sizes of the pellets to some extent by varying the pressure of the steam jets.

At the bottom of the reservoir, on the side opposite the cupolas, there is a well into which the shot gravitates. From this it is removed mechanically, and, after being dried, is fed into the end of an inclined, revolving cylinder. At the opposite or lower end of the latter is an oil-fired burner, the flame of which is blown into the cylinder. Baffles pick up the shot as it progresses through the chamber, and as the cylinder revolves it falls from them through the flames. The shot is rendered brittle by its sudden plunge into the water and would quickly shatter in service: the annealing process removes the brittleness and toughens the metal.

The material flows out of the lower end of the heat-treatment chamber and is elevated and screened. Mixed in with the almost perfect spheres are irregularly shaped pieces called slugs which are larger than the largest commercial size of shot. These are segregated by the screening and are crushed to form grit. This is done in conventional ball mills such as are used in the mining industry for reducing ore for treatment. The mills are cylinders in which the slugs are revolved, together with about 5 tons of manganese steel balls. The size of the grit produced can be controlled by regulating the length of the crushing operation. Twelve sizes are marketed. The shot separated from the slugs is graded by passing it over a series of shaker screens of progressively smaller mesh into the sixteen sizes that are sold. The different sizes thus obtained are directed by gravity through pipes to bins on the lower floor, where they are sacked. Uniform sizing is one of the points emphasized in the company's selling effort.

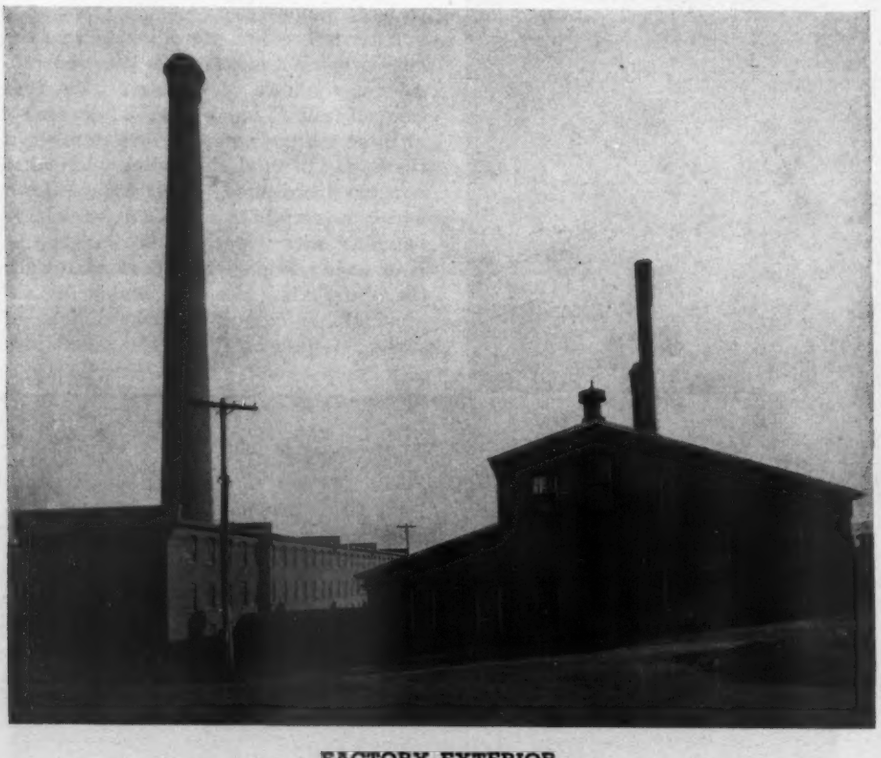
The greatest demand for shot and grit is for cleaning castings and for working stone. The size used for the former purpose depends upon the metal being treated and upon the finish desired. For example, large shot will produce a pebbled surface, while small shot or grit will impart a smooth, satin finish. Among its miscellaneous applications, steel shot serves as a cutting medium in the core drilling of rock. The pellets are crushed beneath the lower edge of a revolving cylindrical bit, forming sharp, angular fragments that gradually wear a circular groove in the stone. Other uses of shot and grit are for weighting articles such as toys, and as a component of iron cements and flares.

The environment of the Harrison Abrasive Corporation is worthy of mention. The plant occupies the foundry located in the former big Amoskeag industrial development which extended along both banks of the Merrimack River for more than a mile. The foundry was established there prior to Civil War days, and during that conflict made firearms and cannon for the Union forces. When the famous ironclad *Monitor* was under construction, John Ericsson, the celebrated engineer in charge, had need of a lathe large enough to grind the ring for the vessel's revolving turret. He found it in this foundry, and the necessary work was done there. Following the war, the plant manufactured the once well-known Amoskeag fire-fighting apparatus and, later, locomotives and boilers.

Manchester, the largest city in New Hampshire, owes its industrial development to the harnessing of Amoskeag Falls for the generation of power. The section was settled in 1722, and the Township of Derryfield was incorporated in 1751. In that year, Judge Samuel Blodget settled there, and in 1793 he began the construction of a canal and locks to permit water transportation around the falls. Having visited Manchester, England, and observed its great industries, he made the statement that his development would transform the community into the Manchester of America. He died three years before the canal was completed in 1807, but his fellow townsmen remembered his statement and, when the Amoskeag Cotton & Wool Manufactury was formed in 1810 to utilize the power at the falls, they changed the name of the place from Derryfield to Manchester.

The Amoskeag firm was the forerunner of the great Amoskeag Manufacturing Company, whose textile mills at one time employed some 16,000 persons. The concern prospered for many years, but closed the mills in 1936, thereby precipitating a critical situation in the economic life of Manchester. To meet the emergency, the city's businessmen formed Amoskeag Industries, Inc., bought the property for $5,000,000, and set out to interest industries in using the facilities. They have succeeded so well that three-fourths of the buildings are now occupied. Instead of but one, 81 firms are now engaged there in widely diversified manufacturing. Although there are fewer employees than formerly, the payroll is as high as it ever was. Amoskeag Industries is a liquidating organization, and through the sale of some of the structures it has got back about $3,500,000 of its $5,000,000 investment.

The Harrison Abrasive Corporation is one of the companies that was attracted to Manchester by the availability of buildings and of labor. Another factor that influenced the choice was the supply of soft water from the White Mountains, for soft water, according to Nathan Harrison, is very important in making high-quality chilled-steel shot.



**FACTORY EXTERIOR**

The shot is made in the historic buildings of the old Amoskeag foundry, where a vital part of the Civil War battle craft "Monitor" was machined.

# All Kinds of Ways to Dig

*Jack Feth*

Photo, Ferenz Fedor

**ARCHEOLOGIST AT WORK**

Dr. Frank C. Hibben, curator of the museum of anthropology at the University of New Mexico, digging in a breccia formation on the floor of Sandia Cave. Underneath this layer was a stratum of yellow ocher that was evidently deposited during a wet geological period. In it were found evidences that the cave had been occupied by man some 25,000 years ago.

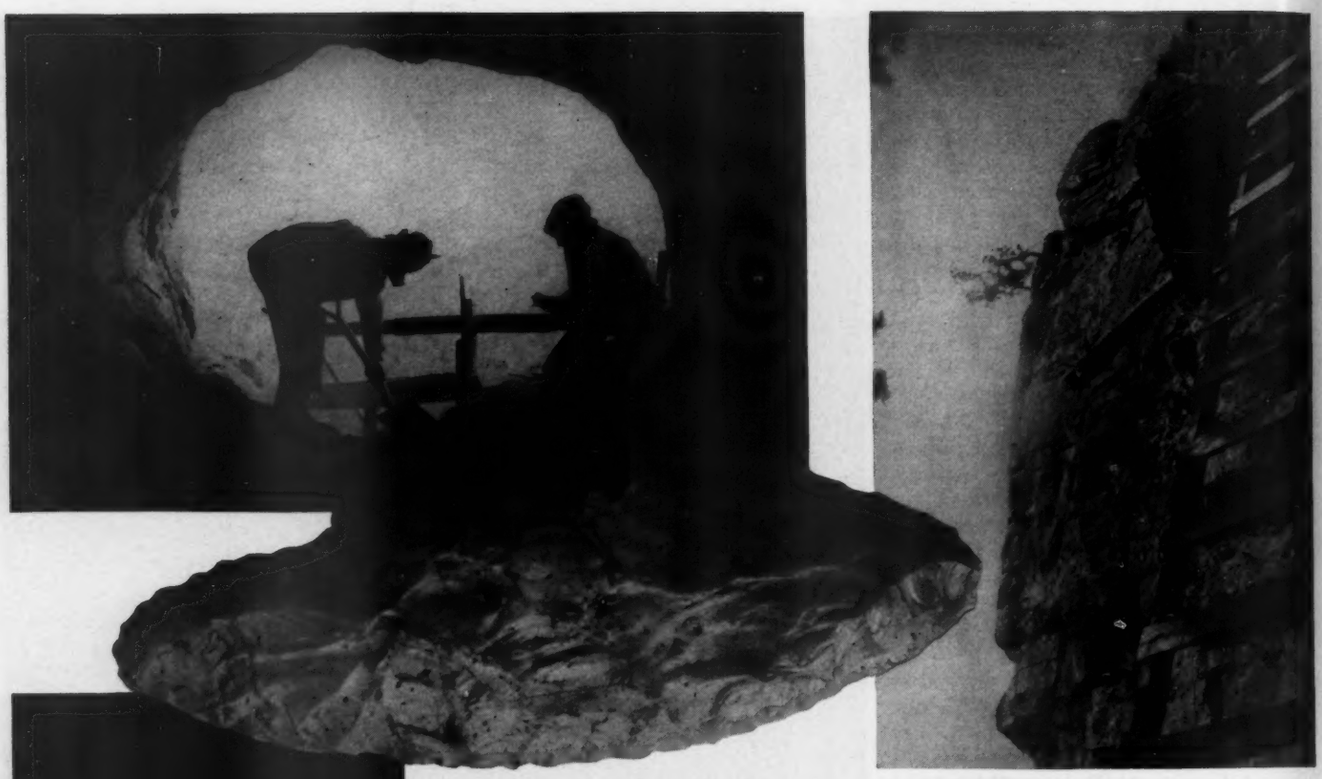
THERE are all kinds of ways to dig especially when one goes in for archeology. The delvers into the secrets of the past employ everything from rock drills to camel's-hair brushes and from sledge hammers to giant vacuum cleaners. There's a party now in Alaska using a bulldozer to unearth mastodon and mammoth bones, which abound in the region. That's one extreme of digging for science. And then there's the work, at the other extreme, of uncovering textiles, centuries old, perhaps in southern Arizona in a cave where the material to be handled is little more than heavy dust laid down in a set pattern. The archeologist then resorts to orange sticks and camel's-hair brushes, painstakingly removing a speck of foreign matter here, a grain of sand there. With the fabric exposed, he must preserve it, reinforce it enough to be able to take it to his museum. Elastic coal-tar compounds discovered in the search for synthetic rubber; Alvar, a resinous compound soluble in acetone; and milky latex, all are used in this endeavor, each preservative serving the purpose for which it is best adapted—one for textiles, another for basketry, another for fragile bones.

Among the varied means of excavating to which the archeologist has recourse, perhaps none is more interesting than the removal of earth by suction. A case in point is a cave in the Sandia Mountains about 18 miles by air from Albuquerque, N. Mex. The problem was to make an archeological "dig" to determine what kind of men called the gloomy passage home in days long gone. And the difficulty was tons of finely divided, cave-dry yellow ocher, just about the dustiest dust you ever saw. It got in the hair, and caked all over anyone who so much as crawled through the cave. It showed all the earmarks of a substance to cause trouble if you didn't wear a respirator, and possibly if you did wear a respirator, it was that fine and that penetrating.

Into this situation stepped Dr. Frank C. Hibben, curator of the museum of anthropology at the University of New Mexico. He had good reason to believe that men of an early race had used the cave for shelter, and troubles or no troubles, he meant to find out once and for all. After preliminary investigations with respirators, he and some of his students tackled the job with air—with suction. Procuring a centrifugal pump and several hundred feet of wire-reinforced rubber hose, they pulley-hauled their equipment from the floor of Las Huertas (The Spirits) Canyon up 75 feet of cliff to the mouth of the cave, a little shelf on the thin edge of nothing. There they set up the pump and its gasoline-motor driver. For an exhaust line they used a 5½-inch hose: for intakes, twin 3½-inch hose lines extending farther and farther into the cave as the work progressed.

The suction lines served two purposes. First, they kept the air in the cave relatively dust-free and fit for human consumption. Second, they removed quantities of loose material, assisting in the actual excavating. This process took care primarily of two strata on the floor of Sandia Cave. The uppermost layer of recent date was finely divided assorted debris, powdery and irritating to the lungs. The suction hose cleaned this off neatly as the workers advanced, a wire screen over the intake preventing larger objects from entering it.

Below the top stratum was a breccia, a calcite-bound aggregate composed of limestone drippings from the cave roof during a wet period in the geological past. This was broken with sledges and geologists' hammers, taken to the mouth of the cave for screening to remove artifacts, bones, and other evidences of occupation. In some instances the slabs were taken to the university laboratories where the material was dissolved in a solution of sugar and hydrochloric acid to permit the recovery, intact, of delicate flint chips and implements that might have been damaged in the chipping-out process. During the work on the breccia layer the dust ma-



**SANDIA SCENES**

The cave is in a perpendicular cliff and 75 feet above the bed of a canyon. A ladder (right) provided the only means of access for the scientists. The exhaust pipe of the improvised vacuum system, that helped in the work of excavating, may be seen hanging out over the face of the cliff. The top view at the left shows workmen at the mouth of the cavern, and at the bottom is an interior view of what was once the home of Sandia Man. In the center is one of the Sandia Points taken from the cave. It is a stone spearhead which is distinguished by the shoulder near the upper left-hand edge.

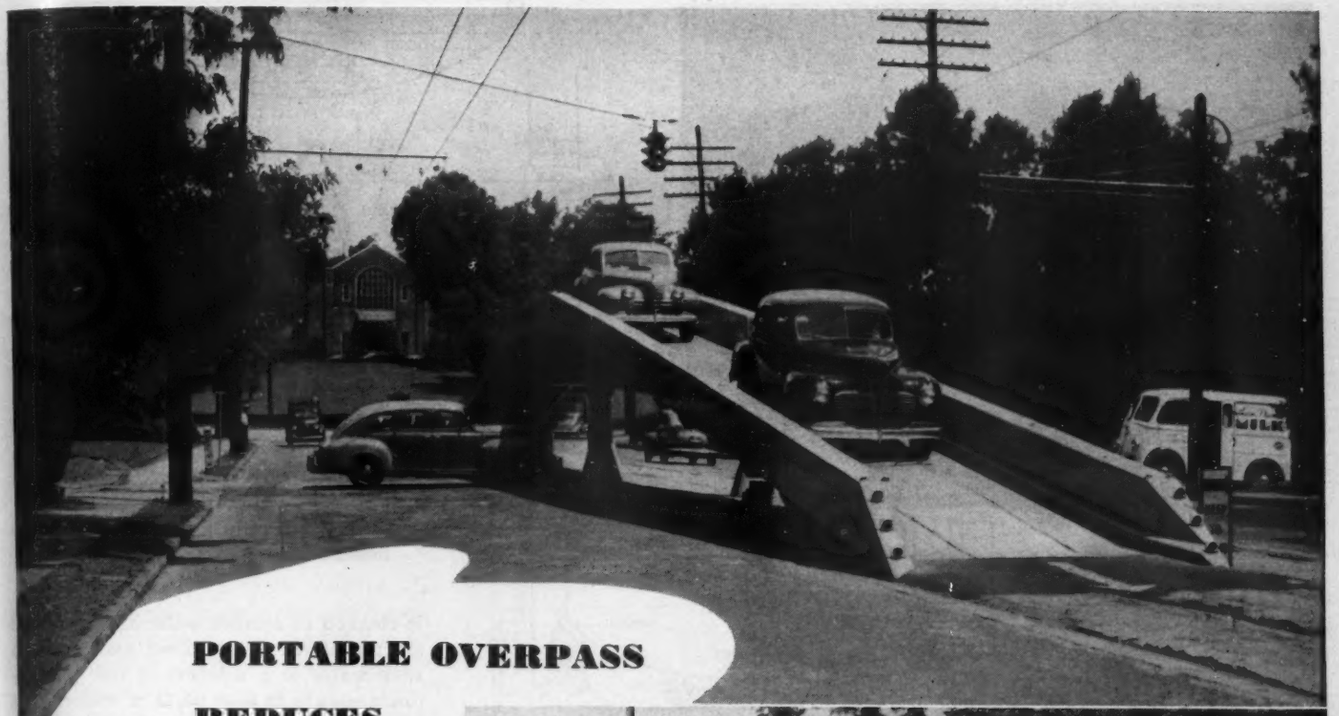
chine kept the air in the cave clear, one intake nozzle being used at the face of the dig and the other at a slightly lower level to pick up and to remove the particles which fell as the breccia crumbled and the dust that was raised in the breaking up operation. Then more excavating with the nozzles themselves, and an exciting discovery!

Underneath the breccia was a stratum of archeologically sterile yellow ocher, sure proof of a long, wet period in geologic time. Now bone dry, the ocher scuffed into clouds of yellow fog at the slightest disturbance. But it yielded readily to suction. For several days the archeologists worked away at the yellow layer, which slowly and cleanly disappeared. And below it, on the very floor of the cave, were evidences of an unknown race of men, earlier even than the Folsom Man, previously thought to be North America's oldest. There in Sandia Cave, under the yellow ocher which geologists say was put down during the last interglacial period, below the breccia in which Folsom Points appeared, right down on bedrock and probably 25,000 years old, were the fire pits of Sandia Man, his distinctive, unmistakable, unique stone implements, and the bones of the prehistoric animals he hunted and lived on—the giant bison, the extinct horse, the North American camel, and the mastodon.

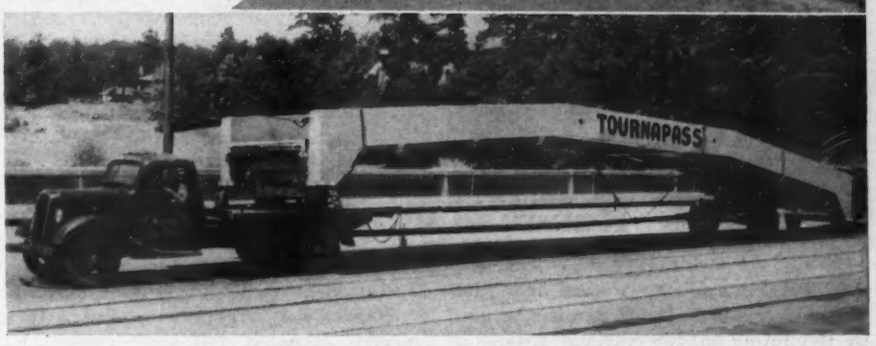
So, with the help of air, a new horizon has been opened up to the scientists, who are trying to reconstruct the history of man in North America. To aid them in this work there is a collection of Sandia Points at the University of New Mexico in Albuquerque and a slash of yellow down the face of a cliff in Las Huertas Canyon where the "dust machine" spilled its exhaust out of the cave to reveal traces of man's occupation of New Mexico 25,000 years back.

Sandia Cave was discovered nearly 20 years ago, and the local people dug around in it unaware of its significance. The existence of the cavern was not made known to the university until 1935. Scientific excavations were conducted in 1936 and 1937, and the work was completed in 1940, funds meanwhile having been provided by the American Philosophical Society. The first official report on the operations and resultant finds was published last year by the Smithsonian Institution. Among the artifacts uncovered are crude stone projectile points—probably spearheads, stone knives known as snub-nosed scrapers, and two projectile heads made of bone. Two sites of ancient hearths also were discovered.

Scientists formerly thought that the forebears of the American Indian came to this continent from Siberia by way of Alaska about 15,000 years ago, and that they were the earliest inhabitants. Then, in 1923, two crude spearheads were found in Mitchell County, Texas, in association with the remains of an ancient fossil buffalo. Two years later similar articles were unearthed near Folsom, N. Mex., and the name Folsom Points was given to them. Since then many more such points have been discovered in Texas, Oklahoma, and New Mexico. Anthropologists are now sure that a race lived on this continent before the arrival of the Indian and that the Sandia Man preceded it, judging from the evidence taken from the New Mexico cave.



# PORTABLE OVERPASS REDUCES TRAFFIC SNARLS




**EASILY ASSEMBLED AND DISMOUNTED**

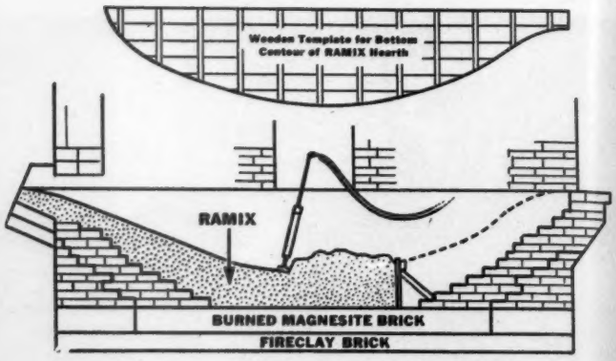
At the top is the experimental Tournapass at a busy intersection in Atlanta, Ga. When it has served its purpose at one point the structure can be shifted to another to relieve a temporary traffic congestion. Being designed to fit traffic lanes, the sections can be moved by railroad or, as shown here, by a trailer-truck. This 2-ton unit hauled a 3-span Tournapass a distance of 125 miles.

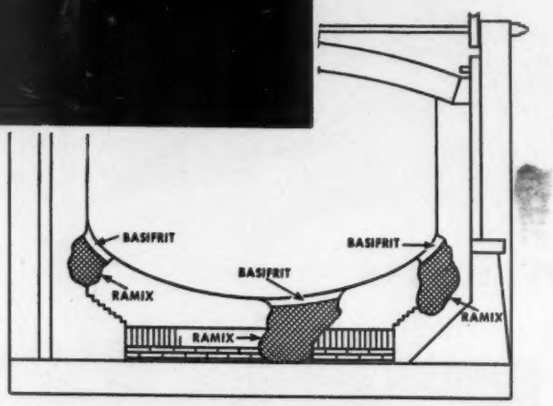
INTERESTING and practical is the new portable Tournapass developed by LeTourneau Company, builder of heavy earth-moving equipment. The structure was originally conceived by Linton Hopkins, Jr., an alert Georgia newspaper editor, who took his idea to R. G. LeTourneau, president of the company. The result is the all-steel overpass shown in the accompanying illustrations. Before offering it to the general public, Mr. W. J. Adams of LeTourneau, working with Mr. Hopkins, arranged to demonstrate the Tournapass in Atlanta, Ga. So that a comprehensive survey could be made, the structure was installed at the busy intersection of Peachtree Street and Wesley Road, and the test was conducted over a 20-day period.

The test determined several important points. First, it was shown conclusively that most of the motorists chose to go by way of the Tournapass instead of the alternate level route. The reason for this is obvious. Because the overpass spanned a dangerous intersection, the users of the Tournapass were not obliged to halt at the red signal. Second, in view of the foregoing, traffic snarls were well-nigh eliminated at the point in question. This, of course, saved time, tempers, and gasoline. Third, the overpass was a factor in averting possible accidents at the intersection.

To provide themselves with representative figures, Adams and Hopkins checked the number of cars which traveled over the Tournapass during periods of heavy traffic. Most of these figures are revealing. For example, the Tournapass, a 1-way, single-lane structure, competed with the regular 2-lane level crossing at which the light is green two-thirds of the time. The public had its choice, and approximately 55,000 cars and light trucks used the Tournapass during the test period. On one Sunday alone, from 7:00 a.m. to 9:15 p.m., a total of 4,685 cars and trucks went over and only 1,581 vehicles took the alternate route. For further checking, a 15-minute interval of peak traffic was selected, namely, 8:15 to 8:30 p.m. Of 165 through-traffic drivers, 150 chose the Tournapass, while only fifteen, one in every eleven, took the level route that was regulated by the stop-and-go signal. Thus, by offering 1-lane uninterrupted flow, the Tournapass eased conditions for all traffic at the busy intersection.

The overpass serves as either a temporary or a permanent structure of three or more spans and can be set up either singly or in pairs. End spans are hinged to the center span by means of giant, alloy-steel bolts which permit adjusting the Tournapass to different street elevations. A 15-ton crane serves to lift the members and to hold them in position while they are being tied together and to the supporting posts provided with adjustable steel bases. It is said that a complete 3-span installation can be assembled in 2½ hours. In spite of its portability and its comparatively light weight, the commercial type will support H-10 and H-15 loads (10- and 15-ton moving loads). A model, consisting of 30-foot spans, designed for the U.S. Army will support like loads. Construction details feature alloy steel, patented box-beam steel side girders, box-beam floor joists, and solid steel floor plate. Each span is a rigid one-piece unit, and passing traffic causes no structure rumble. The Tournapass is built to fit into traffic lanes to permit shipping by truck or railroad.




**APPLYING RAMIX**

The photograph shows a workman tamping Ramix inside a furnace with a pneumatic floor-type rammer. The two drawings illustrate the structural details of the hearth for an electric furnace (top) and how Ramix is used as a repair material in a basic open-hearth furnace (left).

# A Furnace Lining That is Rammed into Place

IN THE metallurgy of steel and other metals, careful attention must be paid to the lining of the various vessels in which the melting is done. The high temperatures developed require the use of refractories that will resist destruction under repeated heatings. Frequent replacement is costly, not only because of the materials and labor required but also because of the production time that is lost. The latter point is of especial importance at this time when maximum output is the aim. Accepted materials for acid open-hearth and electric furnaces have long been clay or silica brick for bottom courses surmounted by silica brick. Basic furnaces have had bottom courses of clay brick and magnesite brick on top of them.

In recent years there has been introduced a granular magnesite refractory that can be mixed with water and rammed into place. It is called Ramix and is made by Basic Refractories, Inc., of Cleveland, Ohio. It is suitable for basic open-hearth and electric furnaces, soaking pits, and holding furnaces, as well as for those utilized for melting copper, lead, brass, nickel, and other nonferrous metals. It is claimed that Ramix bottoms prolong hearth life, reduce maintenance costs, and increase furnace production. Other advantages are that the material can be applied in less time than it takes to lay brick and that it costs less than the latter.

Ramix was originally applied only to electric furnaces, but since then it has been used with entire satisfaction in the other classes of vessels enumerated in the preceding paragraph. In the case of electric furnaces it is the usual practice to melt directly on the Ramix surface: in open-hearth furnaces Ramix generally serves as a subhearth material and is surfaced with 5 or 6 inches of magnesite, although many operators have found Ramix to be sufficiently strong and resistant to be applied to the entire hearth. In all these vessels it is used successfully as a patching material. It can be quickly placed in irregularly shaped holes that are difficult to repair with brick, and it sets in an hour or less.

Ramix can be tamped by hand; but the quickest, best, and least expensive method is to consolidate it with air-operated rammers such as those employed in making foundry molds. The material is shipped in 100-pound bags in the form of a dry clinker composed of fine and coarse particles. It is mixed on the job with just sufficient water to give it good ramming consistency, the recommended amount being 1 gallon to 100 pounds. Because it is quick-setting, mixing is synchronized with tamping so that no batch stands more than fifteen minutes before being placed.

Before Ramix is ahplied, the brickwork is cleaned to remove adhering metal and slag; is blown free of dust; and scrubbed with water or a solution of one part sodium silicate in four parts of water. The latter treatment prevents the bricks from absorbing water from the Ramix before it is tamped into position. Rammers of 6- or 7-inch stroke and 3-inch head are ordinarily used, and are operated with compressed air at 80 to 100 pounds pressure. The material is shoveled into the furnace and applied by one or more rammers. The entire hearth of a small furnace can be tamped as a whole; but in the case of a large furnace the area is divided into sections with wood forms and each section is rammed in turn. After a form has been removed, the exposed vertical face is well roughened to insure a good bond between it and the adjoining section. The Ramix is spread in a layer approximately 5 inches thick, which is compacted to about 3 inches. Before the next one is placed the surface of the rammed underlayer is roughened. The material does not creep under the hammer and, under good conditions, can be tamped at the rate of 1,000 pounds an hour per rammer. After the Ramix surface has been given the desired contour, it is dried with coke, gas, or electric heat, and, where required, granular magnesite with or without an addition of slag is sintered in place over the Ramix.

Last February, in rebuilding and enlarging an open-hearth furnace to 175 tons capacity, a midwestern steel company rammed 66,000 pounds of Ramix to form a 6-inch subhearth in 24½ hours. The subsequent operations of drying, "burning in" a magnesite working hearth, and slagging over, brought the total elapsed time up to 9⅓ days. By June 16 the furnace had turned out 189 heats with a production rate of 16.3 tons an hour, as compared with 10.6 tons before rebuilding, and an over-all shop average of 14.5 tons an hour during the period concerned.

### Putting Silver to Work

SILVER has played the role of the Little Orphan Annie of the metal kingdom for many years, and has been a political football since the era of William Jennings Bryan and his famous "Cross of Gold" speech. Although it is classified as a noble metal, it has not always been noble enough to hold a place in the sun alongside its more glittering companion, gold. As though it were discouraged by these rebuffs, it seems that silver is now to shed its coat of ermine and go to work as a commoner in the cause of military victory.

Silver is relatively plentiful in the United States, and is an excellent material for many industrial applications. Only its comparatively high cost has previously precluded its widespread use for various purposes long filled by baser metals. Now that monetary expenditures are secondary to winning the war, silver has enlisted for the duration. In 1941 the arts and industries of the United States and Canada consumed some 80,000,000 ounces of silver, an increase of 95 per cent over 1940 and an all-time high. The trend is continuing at an even faster pace.

Much silver is already being used as a substitute for copper, brass, stainless steel, and other metals that are difficult to procure. It is easily worked, and can be had in such forms as sheet, strip, rod, tube, and wire. It forms alloys with most common metals, and can be combined with others by means of powder metallurgy. It has strong resistance to corrosion, and its reclaiming value is high. Sterling silver, which consists of 925 parts silver and 75 parts copper, can be hardened by heat-treating or by cold-working. It is the best thermal and electrical conductor we have, and is therefore ideally suited for electrical contacts. Fine silver wire promises to replace fine copper wire in small coils for hundreds of electrical applications. In this case, as well as in parts of small size that require considerable fabricating, the cost of the material often is but a small fraction of the total cost of the product.

Silver brazing alloys make effective joints between metals. Their use is helping to save tungsten for high-speed tools, in which only the tip need be of tungsten-bearing alloy. They can be made mostly of carbon steel, and the two pieces can be joined securely by silver-brazing. The joint contains little silver, for it is less than three-thousandths of an inch thick. Two kinds of lead-silver solder, containing only 2.5 per cent silver, are available for sealing containers, thereby releasing precious tin. Silver, because of its germicidal properties, is also proposed as a substitute for tin for the lining of cans.

The movement to popularize silver for industrial applications is being sponsored by the American Silver Producers' Research Project, the membership of which consists of nine of the leading silver producers of the country. It is being directed by Handy & Harman, New York brokers, who daily fix the price that smelting companies pay for newly mined silver. In addition to giving free advice to manufacturers who are seeking ways to use the white metal, the group is offering free supplies of silver in various forms for experimental purposes to responsible firms.

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### Adieu to Rack-a-Rock

IN THE year 1873, Dr. Hermann Sprengel introduced a new type of explosive consisting of two ingredients, neither of which was explosive in itself. It became popular immediately because the component chemicals could be safely transported and stored and then mixed at the point of application, as required. The most widely used of the various Sprengel mixtures consisted of 79 parts of potassium chlorate and 21 parts of mono-nitrobenzene. It was manufactured under the trade name Rack-a-Rock in Paterson, N.J., by the Rendrock Powder Company.

The latter concern was organized in 1875 by Jasper R. and Addison C. Rand, who previously had formed the Rand Drill Company, pioneer maker of rock drills and air compressors. The Rand brothers sold much of their drilling equipment to mining companies, and they entered the powder business because they found that the mines needed an effective blasting reagent for the holes drilled with their machines. Rack-a-Rock became known far and wide, and quantities of it were shipped to different foreign countries. The U.S. Army Engineers were partial to it, and employed it for blasting in connection with their various river-improvement projects on the Mississippi and elsewhere. The most notable of these works was the clearing of a deep channel for shipping in the swift-running waters of Hell Gate in the East River of New York City. In blowing up Flood Rock in 1885, Gen. John Newton detonated 240,399 pounds of Rack-a-Rock at one time. The blast was considered of such importance that the day on which it was scheduled was declared a holiday.

With the production of new explosives and improved methods of handling them, Rack-a-Rock declined in importance, and the Rendrock Powder Company's activity waned. The Rand Brothers passed on, but Mrs. Henry Lang, a daughter of Jasper Rand, continued its corporate office on her estate in Montclair, N.J., where her father had lived. During World War I, she revived the concern and, with her husband's assistance, found a way to make much-needed ammunition primers by developing the first chemically pure chlorate of potash ever made in America. The venture netted no profit.

Following the war, the company again became dormant, although Mrs. Lang continued to keep it alive. When the present emergency arose, she again offered to put the old concern to work for the Government, but it was concluded it could perform no useful service today. Mrs. Lang therefore decided that there was no point in maintaining the company's corporate existence; and on January 20 of this year it was dissolved with the consent of all the stockholders. So, after 67 years, Rack-a-Rock, once a leader in its line, succumbed to the march of progress.

## New Insulating Material

SOMETHING new in insulating materials was discovered accidentally while experimenting with perlite, which is described as volcanic glass with a concentric, shelly texture and, usually, a notable percentage of water. In investigating the material with the thought of possibly using it in making enamels and other infusible products, L. Lee Boyer noticed that when perlite was exposed to heat well below its melting point it exploded like popcorn and formed a mass lighter than ground cork. Upon examination under a microscope it was found that the product had a porous structure and that the pores were well sealed. Subsequent research revealed that it possessed insulating properties of value.

Near a large deposit of perlite in Superior, Ariz., has been erected a semicommercial plant consisting of a gas-heated cylindrical kiln lined with firebrick. Before the material is fed into one end of it it is first crushed, and in that form explodes in from 30 to 45 seconds when subjected to a temperature of 1,650°F. In less than a minute from the time it enters the kiln, the mass is discharged into a Dorr classifier where the particles of perlite, now 6½ to 7 times their original volume, float while the pieces that did not expand sink to the bottom. When dried and ready for the market the product is pure white, fluffy, and free of impurities.

According to conductivity tests, perlite has insulating properties equal to those of ground cork, rock wool, asbestos, vermiculite, and similar substances. It is claimed to be an especially good fire-resistant material for construction purposes because it will not absorb water and is infusible up to a temperature of 3,000°F. When ground to 40-80 mesh it is suitable for filtering water; and, with the addition of a small percentage of sodium silicate, forms a light fire-resistant coating that adheres to wood, paper, and metal. It is estimated that the insulating material can be made at a reasonable cost, and its production on a commercial scale is soon to be started. A plant with a capacity of 75-100 tons is to be built at Superior, while another, at Phoenix, is to be equipped for the manufacture of varied perlite products.

**ENOUGH SAID**

This poster was designed by Jean Carlu for Uncle Sam's Office for Emergency Management. Originally it bore the slogan "It Takes Both Barrels," but after the attack on Pearl Harbor by the Japanese it was changed, as shown, to express the nation's stand for all-out production and victory.

**SOLDERS AUTOMATICALLY**

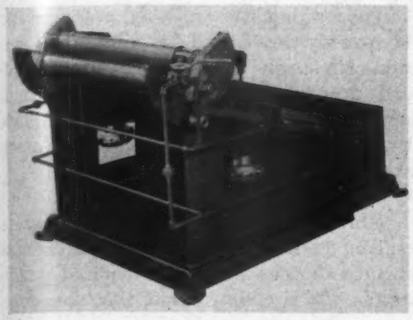
This installation is in the plant of the Fedders Manufacturing Company and is equipped with Westinghouse Electric & Manufacturing Company electric controls. It is viewed from the discharge end and shows the conveyor with finished radiator cores, the press in which the solder is solidified, and the oven directly back of it in which the solder is brought to the flow point.

## Intricate Soldering Job Done Mechanically

AN AUTOMOBILE radiator is a maze of copper tubes and fins requiring hundreds of soldered joints. Until of late it was a complicated hand job; now it can be done automatically from start to finish. The machinery—an oven and a press—have been changed over from manual to electric control and linked by a handling system—all synchronized to operate as a single unit.

The assembly of tubes, fins, and solder is put in position on the electric conveyor, which passes it through a flux spray before entering the oven. After a fixed time, long enough to bring the solder to the flow point, the conveyor starts again and carries the radiator core from the oven into the press, where it is held flat and square while a blast of air "cooks" it and solidifies the solder. When sufficiently cooled, the press opens and deposits the finished work on the conveyor ready for removal.

## Air-Operated Machine for Bending Sheet Metal



**FORMS 80 CASES AN HOUR**

This bending machine forms 16-gauge sheet metal into side panels for powder boxes approximately 24 inches long and 9x16 inches in cross section. The unit is operated with air at from 80 to 100 pounds pressure per square inch.

COMPRESSED air serves a dual purpose in the new bending machine developed by The Berkeley Equipment Company. The machine is designed to bend sheet metal, the one illustrated here being used for forming the side panels of powder boxes. A sheet of 16-gauge is placed on the sloping bed, with one end inserted between the two rolls, and is clamped and bent to the desired angle by air under pressure applied by means of four pneumatic cylinders, two on each side. The bending action is caused by the movement of one roll around the other, with the sheet between them. The bend radius is that of the holding roll, while the bend angle is set by the angle of movement of the active roll, which is controlled by the movement of double-acting power cylinders. Clamping is done by diaphragm cylinders. The position of succeeding bends is determined by gauge bars across the sloping bed.

The rolls are mounted on shafts assembled in quadrants at the sides of the machine and are geared together so that any movement between them is that of rolling. The shaft at the center of the quadrant is supported by arms hinged to the housing and connected to rods actuated by the diaphragm cylinders. The quadrants, in turn, are geared to racks that are supported on rollers and form the ends of the pistons of the power cylinders. By this arrangement both sets of cylinders are operated through a 4-way valve, a single turn serving to admit air to clamp the metal and to bend it, or to release the forming roll and to return it to the down position.

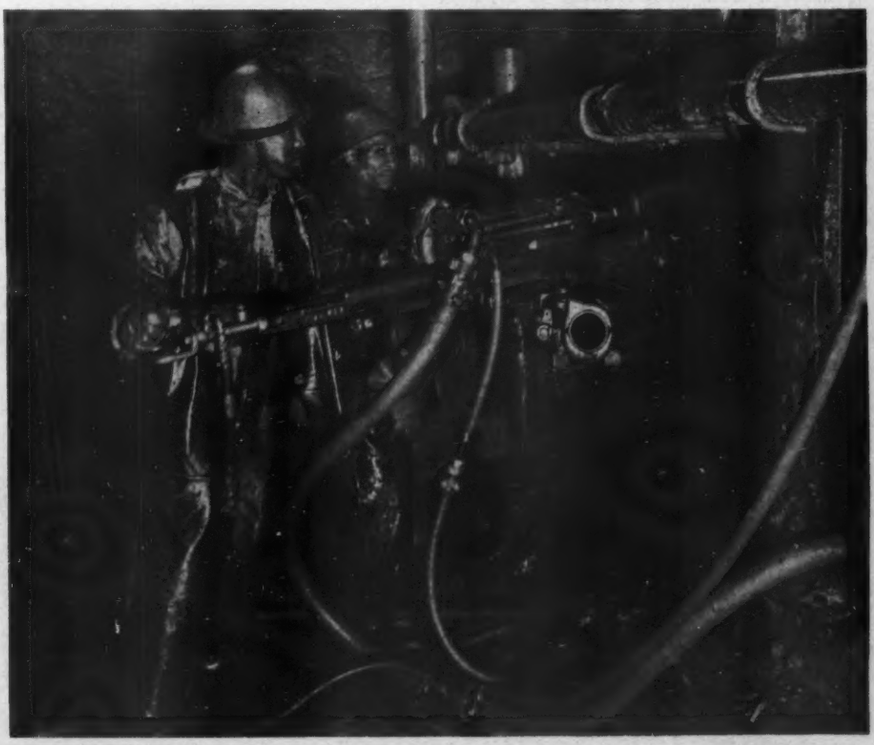
## Blasting Agent and Fire Extinguisher in One

THOUGH primarily designed to break down coal, Cardox shells, which are filled with carbon dioxide, are potential fire extinguishers and are used for both purposes in some of the mines of the Pittsburgh Coal Company. Within easy reach of each working area is a rack containing from 40 to 60 of the shells, together with a ⅜-inch Allen safety wrench in a glass-inclosed case. Another wrench is carried in the tool box of each loading machine. Placards posted on the rack and the mine doors give instructions in the use of the shells in case of fire.

The carbon dioxide is released by opening the inlet valve on the heating end of the shell, which can be held in the hand to spurt the fluid on the flames or thrown on it. The system is standard in the company's collieries where Cardox is the blasting agent, and is said to have proved its effectiveness by putting out several small fires that otherwise might have spread to dangerous proportions.

## Powerful Rock Drill for Jumbo Service in Tunnels and Mines

THE D-505 drifter shown here is the latest addition to the Ingersoll-Rand family of rock drills and has been developed to fill the need for a strong, powerful, and efficient machine for jumbo service in tunnels and mines. It incorporates new and improved features and is said to be the fastest and most durable drill of its type ever produced by the company. Compared with the previous 4-inch-bore drifters, exhaustive tests have shown that the efficiency of the D-505, based on inches drilled per cubic foot of air, is 34 per cent greater at 90 pounds pressure and 52 per cent greater at 70 pounds pressure. Further, the wall section of the fronthead is 10 per cent thicker; the shank aligner is 18 per cent longer and 8 per cent thicker; and there is an improved chuck of heavier construction, all making for a more rugged machine. The design of the piston-stem cushion bearing permits the use of a heavier metal section in the cylinder and furnishes better support. There is a port on each side of the cylinder, a feature which serves to balance the piston. The air reaches the front end of the cylinder by passing directly between the ratchet and the rifle bar—is unrestricted by small ports. This assures good hole-cleaning and is of aid in keeping all moving parts continuously lubricated. The new drifter is provided with a sturdy rifle bar that makes for strong rotation, and the rifle-bar pawls are reversible for longer life. The throttle handle is well protected by the backhead and yet readily accessible. Detailed information about the D-505 is contained in Form 2786, which can be obtained from Ingersoll-Rand Company, 11 Broadway, New York, N.Y., or any of its branch offices.



**IN SERVICE**

One of the new D-505 drifters drilling holes in a tunnel heading. It is mounted on the lower platform of a drill carriage equipped with seven machines.

# Industrial Notes

Ground talc, we are informed by the U.S. Bureau of Mines, is being used in Great Britain for smothering incendiary bombs.

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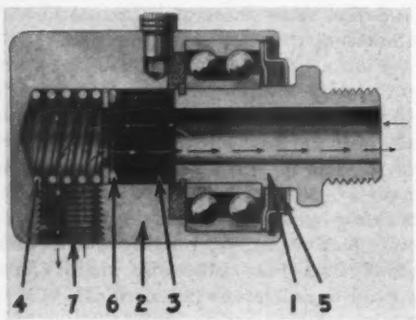
Rotorseal is the name of a new device that is designed to act as a positive seal at the point where air or oil, under pressure or vacuum, is transmitted from a stationary to a rotating member, or from a rotating to a stationary member. It consists essentially of a hollow shaft and of a housing in which the former rotates in a sealed, double row of ball bearings. Closure is effected by a special nonmetallic, tubular seal nose bearing against the face of the shaft. Bearing surfaces are self-adjusting by virtue of a spiral spring that




**LONGITUDINAL SECTION**

1, Shaft; 2, housing; 3, seal nose; 4, spring; 5, felt-wiper ring which prevents dirt from entering the seal; 6, washer which guards against leakage between nose and housing; 7, pipe tap. The arrows indicate that the Rotorseal can be used to allow the air or oil, under either vacuum or pressure, to flow in one or the other direction—from left to right from a stationary to a rotating member, or from right to left from a rotating to a stationary member.

compensates for wear and maintains a constant and positive seal with minimum friction. The unit is supplied with a short length of rubber hose and the necessary fittings ready to screw into the pipe tap in the side of the housing. It is a product of the Kellogg Division of the American Brakeshoe & Foundry Company, and the claim made for it is that it can be run continuously in either direction and can be reversed as often as necessary. Rotorseal is suitable for use with pressures up to 150 pounds per square inch, at temperatures up to 200°F., and speeds up to 2,000 rpm. It is now offered in five sizes with passages ranging from ¼ inch to 1½ inches in diameter.

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Infrared lamps, which are playing such an important part in drying and baking paints, finishes, etc., are being used to shrink-fit hard and soft metal parts and are said to do the work far more satisfactorily than by the press-fit method. In a plant in Lima, Ohio, which turns out small motors, a rotary conveyor, traveling 30 feet a minute, carries aluminum motor frames through a tunnel made up of a battery of fifty-six 375-watt lamps. In their passage through the oven, the frames are heated to a temperature of 302°F., causing the bore of 6.75 inches to expand 0.20 inch, or enough to permit dropping the wound primaries in place.

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For curing concrete paving, the Central Paper Company offers what it calls Centraline Road Coat. It is made of tough, waterproof Kraft and burlap with a paper backing and comes in sheets 6 feet wide and 24 feet long, sufficient to cover a 22-foot slab. Special sizes are made to order. It is claimed that the material expedites curing by sealing in the water, makes sprinkling unnecessary, and can be used repeatedly.

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Florite Desiccant, a new granular drying agent for gases and liquids, has recently been placed on the market by the Floridin Company. Now being dehydrated by this desiccant are natural gas, propane, gasoline, nitrogen, carbon dioxide, and air. It may be used in breathers for storage tanks and electrical transformers, as well as to dehumidify air in air-conditioning systems and to dehydrate refrigerants. Hard, stable, noncorrosive, and nonpoisonous, the desiccant absorbs water instantly, it is claimed. It can be regenerated by heating to 300-350°F.

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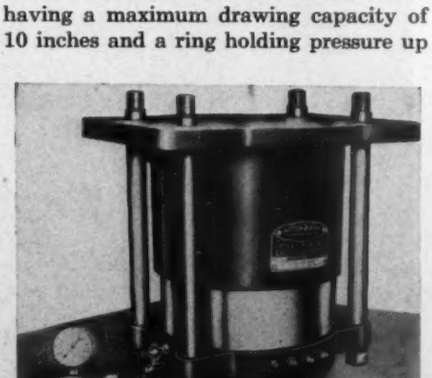
The Dayton Rogers Manufacturing Company has recently announced an improved pneumatic die cushion designed for drawing and forming operations. The self-contained Model DB Universal is adaptable for most press work of this kind and is available in sizes from 6 to 20 inches having a maximum drawing capacity of 10 inches and a ring holding pressure up



to and including 15 tons. The unit automatically maintains a predetermined pressure on either the draw ring or pressure pad by means of a combination regulator and gauge; and by keeping a record of the gauge reading, the working pressure can be quickly duplicated for subsequent setups. No surge tank is required for standard drawing operations. The die cushion can be fastened to the bolster plate by drilling four holes for the mounting studs.

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Whitex is the trade name of a white tracing cloth with a specially processed surface to take black and colored pencil marks. It is claimed that the blueprints are good and clear and that erasures with soft rubber or art gum do not show on them. The material is made by The Frederick Post Company which offers to send samples upon request.

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In addition to its line of self-lubricating bronze bearings, the Keystone Carbon Company, Inc., is now prepared to supply Selflube porous iron bearings. The latter are said to be stronger than the bronze bearings, with which they are interchange-

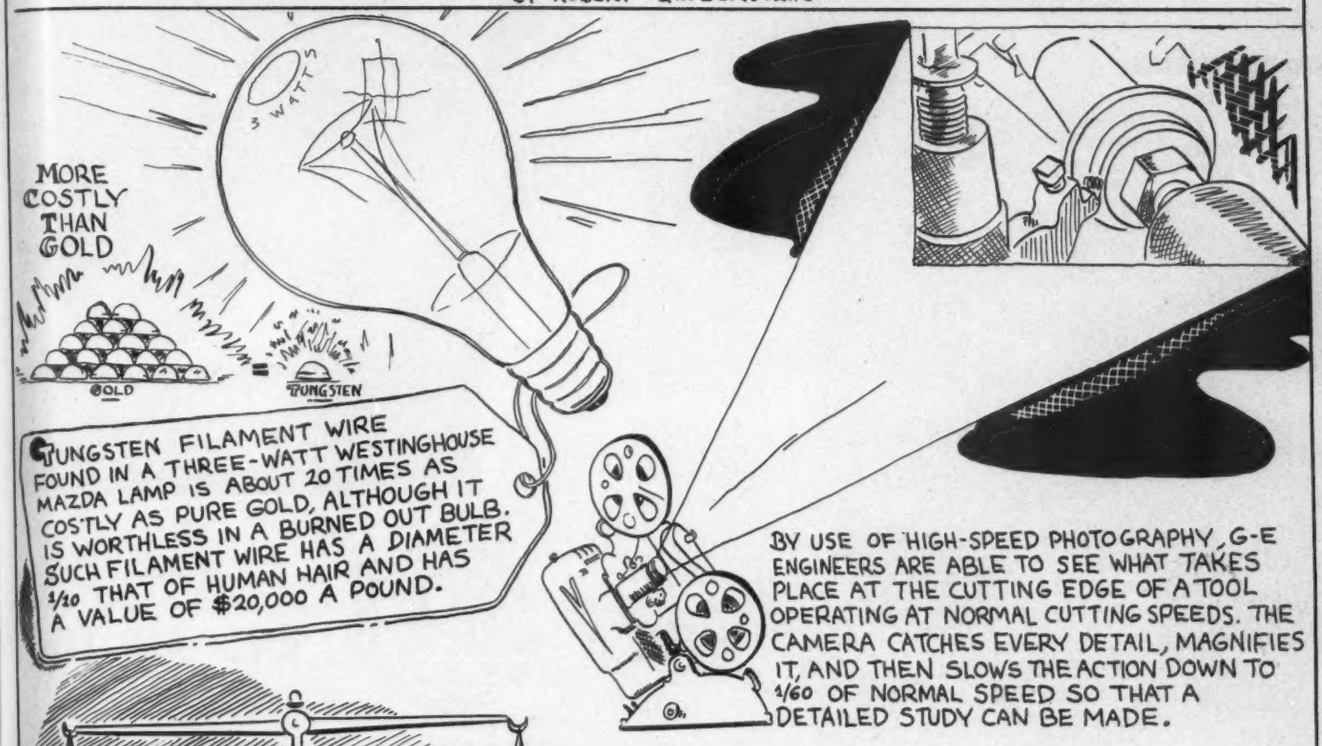
**STANDARD AND SPECIAL SHAPES**

1, Sleeve or plain cylindrical bearing; 2, washer or thrust bearing; 3, spherical or self-aligning bearing; 4, flanged bearing; 5 and 6, special shapes.

able for most applications. They are made of powdered iron, which is molded to close dimensional tolerances in the shape desired, baked, and then saturated with a good grade of oil. They have an average porosity of 25 to 35 per cent, enabling them to store a large amount of oil which keeps a protective film on the bearing surface. The supply often lasts as long as the bearing, thus eliminating the use of oil vents or grease cups. Additional lubrication is recommended for heavy-duty or continuously operating units. The new bearings have a low friction coefficient which, together with their self-oiling properties, prevents excessive temperature rises, speed reduction, noise, and shaft scoring.

# FEATS & FACTS

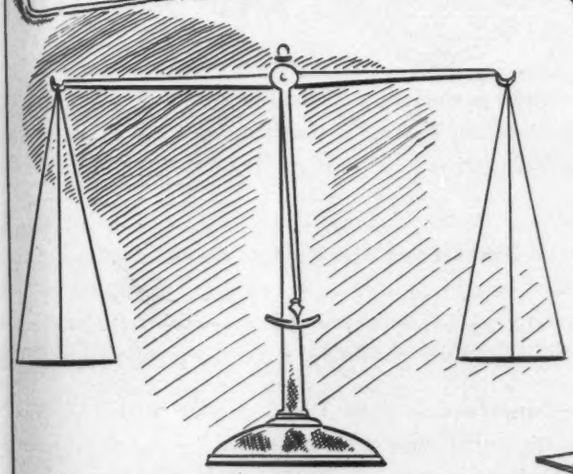
BY ROBERT GLUECKSTEIN



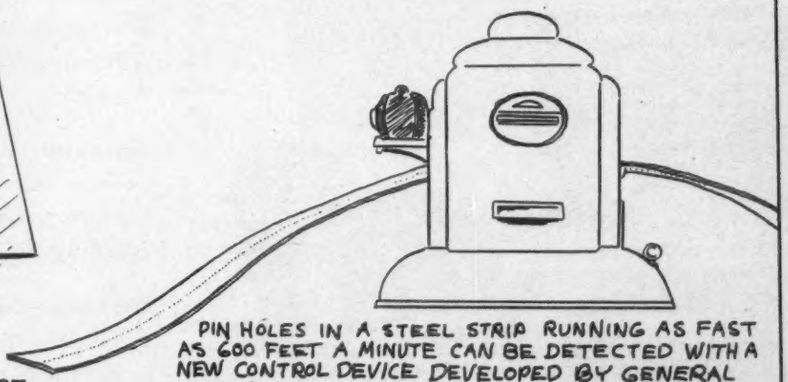

TUNGSTEN FILAMENT WIRE FOUND IN A THREE-WATT WESTINGHOUSE MAZDA LAMP IS ABOUT 20 TIMES AS COSTLY AS PURE GOLD, ALTHOUGH IT IS WORTHLESS IN A BURNED OUT BULB. SUCH FILAMENT WIRE HAS A DIAMETER 1/10 THAT OF HUMAN HAIR AND HAS A VALUE OF $20,000 A POUND.



BY USE OF HIGH-SPEED PHOTOGRAPHY, G-E ENGINEERS ARE ABLE TO SEE WHAT TAKES PLACE AT THE CUTTING EDGE OF A TOOL OPERATING AT NORMAL CUTTING SPEEDS. THE CAMERA CATCHES EVERY DETAIL, MAGNIFIES IT, AND THEN SLOWS THE ACTION DOWN TO 1/60 OF NORMAL SPEED SO THAT A DETAILED STUDY CAN BE MADE.



ONE OF THE WORLD'S MOST DELICATE SET OF SCALES CAN DETERMINE THE WEIGHT OF A HUMAN HAIR OR A MAN'S SIGNATURE. THE SIGNATURE OF GEORGE WASHINGTON, WRITTEN IN PENCIL, WEIGHS .00089 GRAMS OR 2/10ths OF A THOUSANDTH OF A GRAM. THE WEIGHING INSTRUMENT IS USED TO CHECK THE DIAMETER OF FILAMENT WIRE USED IN WESTINGHOUSE MAZDA LAMPS. IT IS ACCURATE WITHIN 40 BILLIONTHS OF A POUND.



PIN HOLES IN A STEEL STRIP RUNNING AS FAST AS 600 FEET A MINUTE CAN BE DETECTED WITH A NEW CONTROL DEVICE DEVELOPED BY GENERAL ELECTRIC. WHEN A FLAW PASSES THROUGH THE SCANNING HEAD OF A PHOTOELECTRIC DETECTOR THE DEVICE NOT ONLY DETECTS THE HOLE BUT THROWS OUT THE FAULTY SECTIONS.

THE UNION PACIFIC R.R. CLAIMS THE LARGEST AND MOST POWERFUL STEAM LOCOMOTIVE EVER BUILT IN ITS NEW 596-TON, 132-FOOT, 7,000 HORSE POWER UNIT FOR WESTERN SERVICE

# *On Your Small Jobs*

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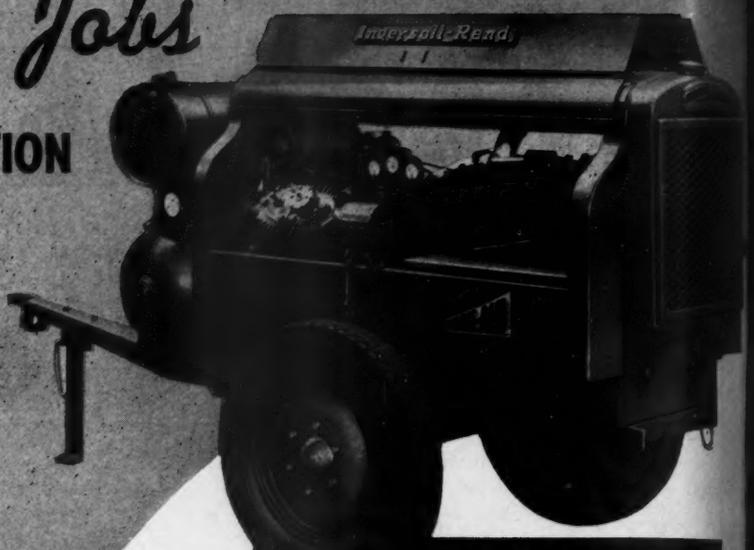
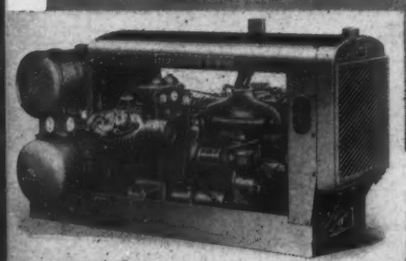


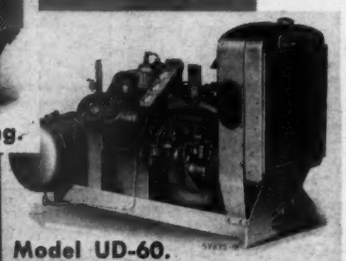
MODEL D-85
the NEW 85 cu ft Size

Model D-60
60 cu ft Size.

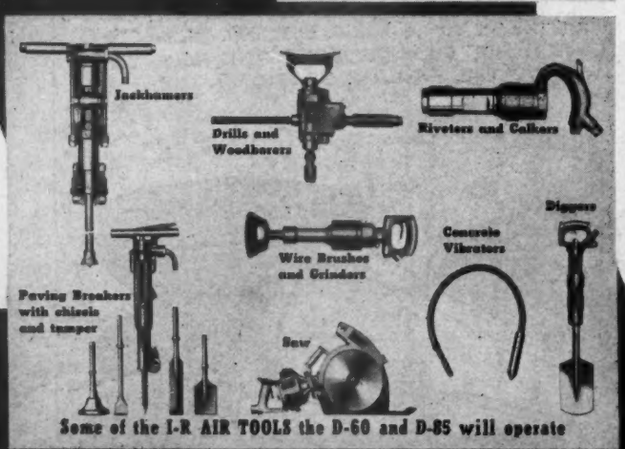
## WITH A MOBIL-AIR AND AIR TOOLS



Model UD-85 for truck mounting.



Model UD-60.




Some of the I-R AIR TOOLS the D-60 and D-85 will operate

**Ideal for small projects . . .** These handy little compressors... and the air tools they operate... make an ideal AIR-POWER UNIT. They are gasoline operated . . . ready to go to work anywhere . . . anytime.

**Economical Units that Speed-up Work . . .** Being inexpensive, light-weight, and easy to handle, the D-60 or D-85 enables public works departments and construction men to speed-up their work by putting AIR TOOLS on their jobs.

**On Large Construction Jobs** these smaller MOBIL-AIR units can handle the urgent here-and-there jobs, permitting the larger compressors to stay on their regular work.

**High-Quality . . . Two-Stage Air-Cooled . . .** The D-60 and the D-85 are the "little brothers" of the new K-Series MOBIL-AIR which are built in 105- to 500-cu ft sizes. They are extremely compact, light-in-weight, and sturdy . . . built for the smaller jobs, yet with sufficient capacity for operating most air tools. They are simple in construction, but include everything you need.

*Send for New Bulletin 3076*

2-89

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